Initial Environmental Examination

October 2017

Thailand: Greater Mekong Subregion Highway Expansion Phase 2 Project

Prepared by the Ministry of Transport through the Department of Highways for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 13 August 2017)

Currency unit	–	Baht (THB)
THB1.00	=	$0.030
$1.00	=	THB33.20

ABBREVIATIONS

AADT	-	Annual average daily traffic
ADB	-	Asian Development Bank
AP	-	Affected person
BOD	-	Biochemical oxygen demand
CEMP	-	Contractor's Environmental Management Plan
CO	-	Carbon monoxide
CSC	-	Construction supervision consultant
DMC	-	Developing member country
DOH	-	Department of Highways
EHS	-	Environment, Health and Safety
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
EWEC	-	East-West Economic Corridor
GHG	-	Greenhouse gas
GMS	-	Greater Mekong Subregion
GRM	-	Grievance Redress Mechanism
IEC	-	International Electro-technical Commission
IEE	-	Initial Environmental Examination
ITCZ	-	Intertropical convergence zone
IUCN	-	International Union on Conservation of Nature
MONRE	-	Ministry of Natural Resources and Environment
MOT	-	Ministry of Transport
NEQA	-	National Environmental Quality Act
NGO	-	Non-government organization
NH22	-	National Highway 22
NH23	-	National Highway 23
NO_2	-	Nitrogen dioxide
NOx	-	Oxides of nitrogen
ONEP	-	Office of Natural Resources and Environmental Policy and Planning
PCP	-	ADB Public Communications Policy (2011)
PM_{10}	-	Particulate matter < 10 micron
$PM_{2.5}$	-	Particulate matter <2.5 micron
PMU	-	Project Management Unit
PONRE	-	Provincial Office of Natural Resources and Environment
REA	-	Rapid environmental assessment
ROW	-	Right-of-way
SO_2	-	Sulfur dioxide
SOx	-	Oxides of sulfur
SPS	-	ADB Safeguard Policy Statement (2009)
TSP	-	Total suspended particulates
UNFCC	-	United Nations Framework Convention on Climate Change

WEIGHTS AND MEASURES

ha	–	hectare
m	-	meter
km	–	kilometer
ppm	–	Parts per million
mm	-	millimeter
km	-	Kilometer
µg/m^3	-	Microgram per cubic meter
µm	-	micron
hr	-	hour
dB	-	decibels
^oC	-	Degree Centigrade
Hz		hertz

NOTE

In this report, "$" refers to US dollars.

This initial environmental examination is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

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EXECUTIVE SUMMARY

A. Introduction

1. The Council of Ministers of the Government of the Kingdom of Thailand assigned the Ministry of Transport (MOT) through the Department of Highways (DOH) to develop an action plan for the construction of national highways with four lane carriageways across the regions in the country. The plan aims to provide road users with safe, convenient, and secure means of travel in accordance to international standards. In line with this, the DOH developed a feasibility study for the construction of additional lanes in 18 existing road networks. As of April 2016, the DOH has completed 3,538.60 kilometers, representing 67.14 percent of the target. There are still ongoing road widening projects covering about 658.37 kilometers while budget for 1,073.50 kilometers is still needed to complete the plan.

2. The proposed Greater Mekong Subregion (GMS) Highway Expansion Phase 2 project will supplement the fully completed Phase 1 loan from the Asian Development Bank (ADB) covering upgrades to Highway 12 from Phitsanulok to Lom Sak (105 km) and Highway 359 from Phanom Sarakham to Sa Kaeo (73 km). The Government has requested the ADB for financing to implement the widening from 2-lane carriageway to divided 4-lane carriageway of sections of National Highway 22 from Nong Han to Phang Kon (36.58 km) and from Sakon Nakhon to Nakhon Phanom (33.26 km) and sections of National Highway 23 (NH23) from Roi Et to Yasothon (55.06 km). The project will be implemented by the MOT through the DOH as executing agency.

B. Project Rationale

3. The upgrading from 2-lane road to 4-lane road is in line with Thailand's Eleventh National Economic and Social Development Plan, 2012-2016. The proposed project aims to provide better connection to different regions of the country and between major cities and main towns. The upgrades on NH22 and NH23 will also promote international trade and cooperation between Thailand, Laos People's Democratic Republic (Lao PDR), Viet Nam and the People's Republic of China (PRC) through development of efficient road infrastructures that are linked to neighboring countries. The project is expected to help promote development of economy, trade and industry and bring forth more investment and employment opportunities. The road widening will also accommodate anticipated future traffic growth.

4. NH22 and NH23 are located in northeastern Thailand and are within the GMS East-West Economic Corridor (EWEC). The NH22 ends at the Thai border in Nakhon Phanom where the Third Mekong International Bridge links Thailand with Thakek District of Khammouane Province in Lao PDR. NH22 and the Nakhon Phanom border are used as the main freight transportation route between Thailand and Guangxi Zhuang Autonomous region, PRC through Lao PDR and Viet Nam. The NH23 ends at Ubon Ratchathani Province, which also shares a border with Lao PDR through a NH217 road link to Champassak Province in Lao PDR. Similar to NH22, NH23 is also expected to be an important route of international freight between the neighboring countries.

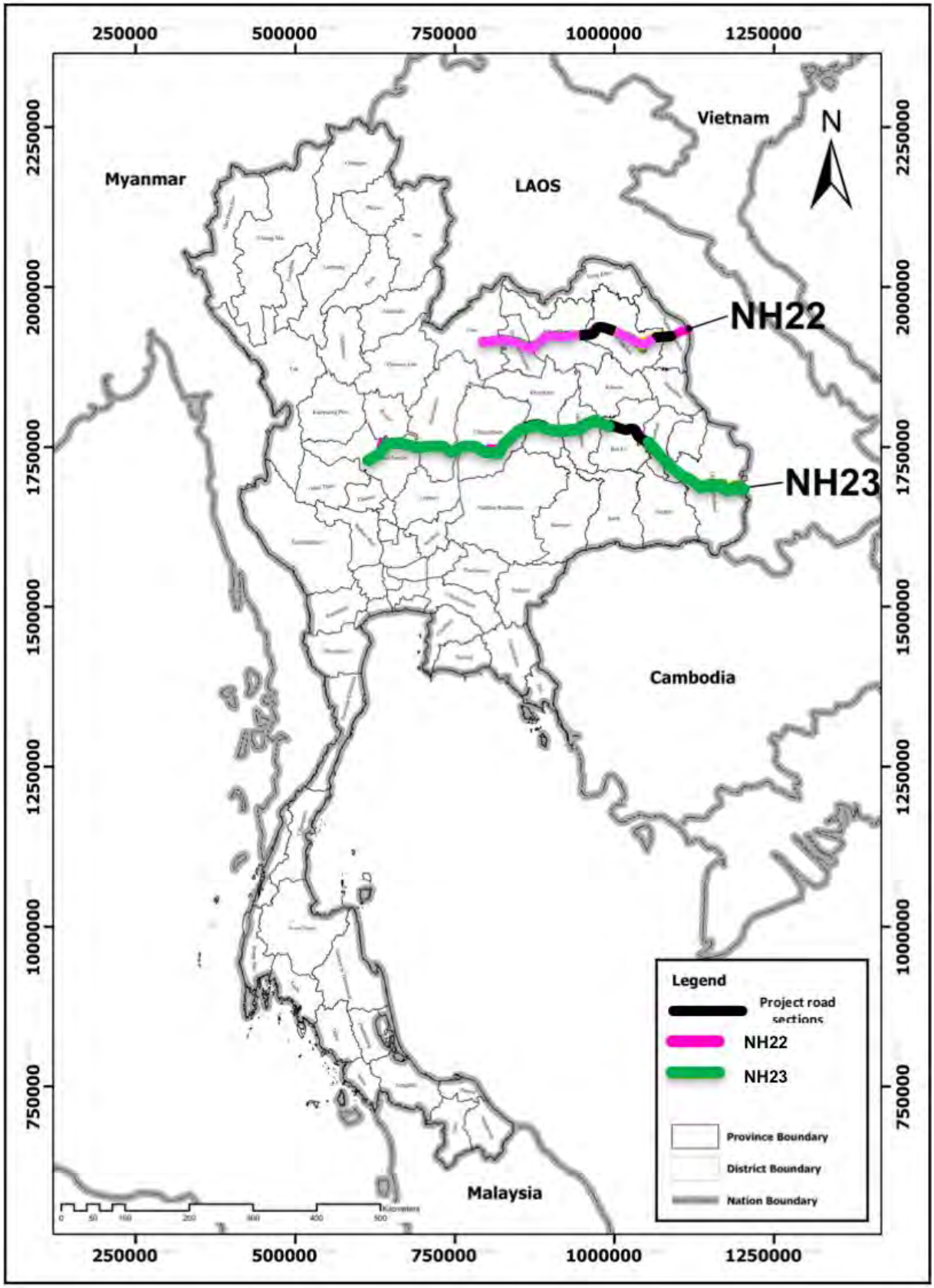

Figure 1: Project Location

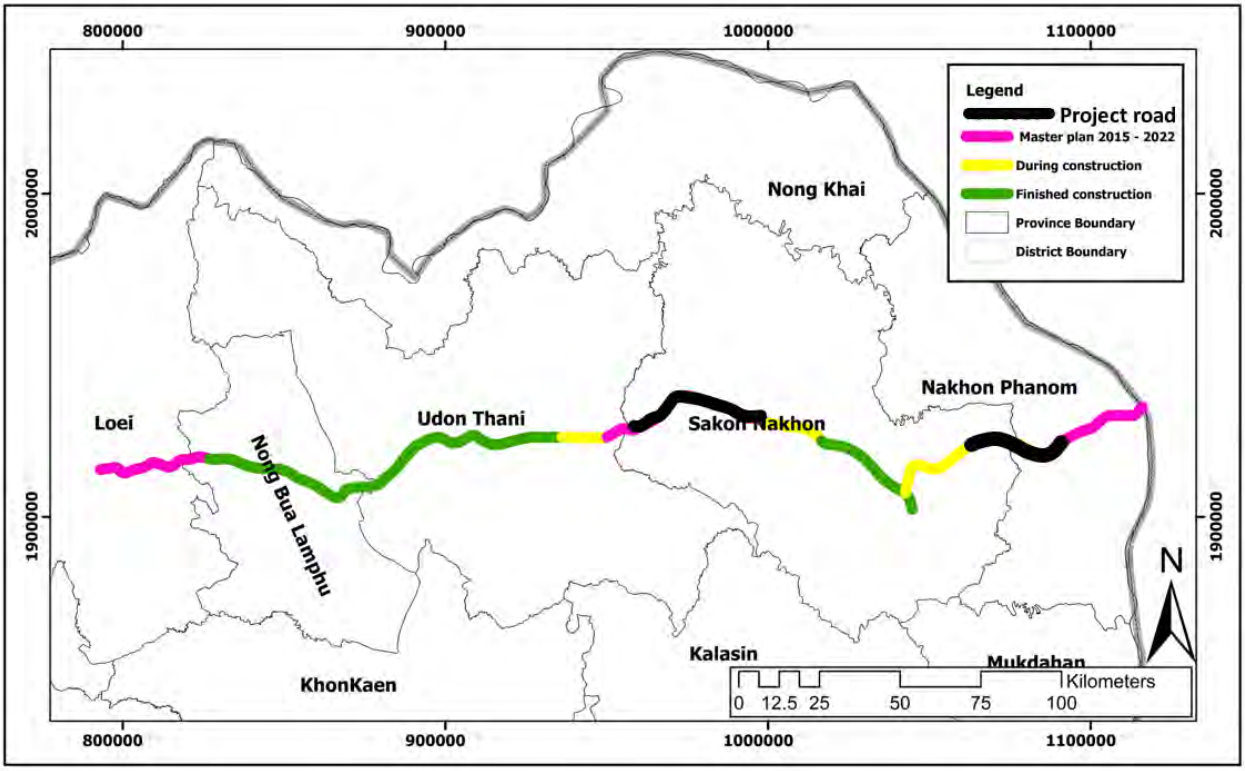

Figure 2: Project Location at NH22

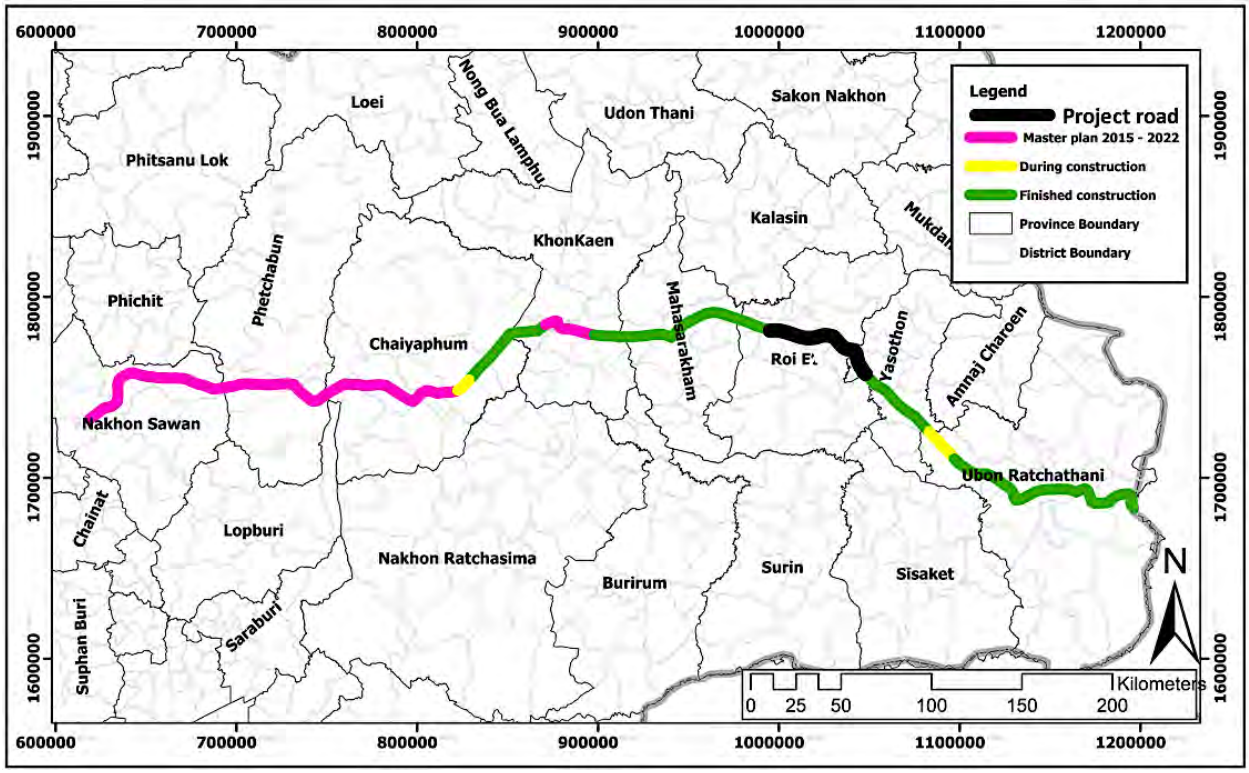

Figure 3: Project Location at NH23

C. Project Activities

5. The proposed project will upgrade a total of 124.90 km sections of NH22 and NH23 from single two-lane carriageways to divided four-lane carriageways. Road sections under the project are from Nong Han to Phang Kon (36.58 km) and from Sakon Nakhon to Nakhon Phanom (33.26 km) of NH22 and a section from Roi Et to Yasothon (55.06 km) of NH23. The road improvement project will involve the following activities: (i) construction of additional two lanes in sections of NH22 and NH23, including widening of existing bridges; (ii) provision of depressed or elevated central median to provide physical separation; (iii) provision of side drains on both sides of the highway; and (iv) surfacing with asphalt concrete pavement. All proposed road improvements would be constructed within the 60-meter road right-of-way (ROW) that was established through Royal Decrees.

D. Purpose and Methodology of Environmental Assessment

6. A screening was carried out using ADB's Rapid Environmental Assessment (REA) checklist. The screening established that the project would not encompass any protected area and ecologically sensitive and culturally significant areas. However, there are sensitive receptors such as schools, hospitals, health centers, temples and offices within the vicinity of the highway that may be affected by nuisance from noise and dust and temporary restriction of access during project implementation. There are also trees that need to be cut within the ROW. The adverse environmental impacts are not expected to cause irreversible effects and that these impacts can be controlled or mitigated through implementation of an environmental management plan (EMP).

7. In accordance with the EIA rules and guidelines as outlined in Thai Government Gazette dated 20 June B.E. 2555 (A.D. 2002) and Section 44(3) of the Notification of Environmental Protected Area, the widening of NH22 and NH23 does not require an environmental clearance from the Office of Natural Resources and Environmental Policy and Planning (ONEP) since the roads do not traverse ecologically sensitive areas. An initial environmental examination (IEE) checklist for each road section was prepared by DOH and submitted together with the feasibility study of the project for approval by Cabinet. The Cabinet approved the project on October 19, 2016.

8. The project is Category B for environment based on ADB Safeguard Policy Statement (SPS, 2009). This Initial Environmental Examination (IEE) report is prepared for the project in accordance with ADB SPS (2009), ADB Operational Manual Section F1/BP, and Public Communications Policy (ADB PCP, 2011). The national environmental regulations and the World Bank Environment, Health and Safety (EHS) Guidelines applicable to road projects are also referred to in this IEE.

9. The purpose of the environmental assessment is to identify environmental and social issues associated with the project. Field assessments of the environmental condition within the project area were carried out in December 2016 to April 2017 while public consultations were held on March 6 – 14, 2017. Environmental sampling for ambient air quality (PM_{10}, TSP, SOx, and NOx)[1], noise levels, and vibration was conducted in four monitoring stations on April 3 – 6, 2017 to establish baseline environmental conditions along NH22 and NH23. United Analyst and Engineering Consultant Company, Ltd., a Government-recognized third party sampling group, was commissioned to conduct the environmental sampling. Secondary data from the Provincial

[1] PM10 – particulate matter micron 10; TSP – total suspended particulates; SOx – oxides of sulfur; NOX – oxides of nitrogen

Office of Natural Resources and Environment (PONRE), Provincial Forest Departments and other Government agencies were also gathered. DOH conducted an inventory of trees within the ROW to identify the tree species within the ROW and the tree diameter. A survey of sensitive receptors such as schools, hospitals, temples and shops was also undertaken. Meetings with the Provincial Forest Department of Nakon Phanom, Sakon Nakhon, Roi Et and Yasothon were held from April 3 – 5, 2017. The Provincial Forest Departments said that removal of trees along the road ROW will be undertaken by the Forest Industry Organization (FIO) following the procedures outlined under the Forest Act. The procedures and requirements for the cutting of trees in the ROW are discussed in Chapter 2.

10. This IEE presents the key information on the project, including findings during the field visits, results of environmental sampling, and issues raised by stakeholders during the public consultation activities. The potential impacts and required mitigations are outlined in the EMP and environmental monitoring plan that will be included by DOH in the bid documents for civil work contracts.

E. Environmental Condition at Project Sites

11. **National Highway 22.** NH22 traverses the provinces of Sakon Nakhon and Nakon Phanom. The project will traverse 37 villages, 18 sub-districts and six districts consisting of Sawang Daen Din, Phang Kon, Phon Na Kaeo, Kusuman, Mueang Sakon Nakhon, and Meuang Nakhon Phanom.

12. There are two road sections in NH22 that will require widening to four lanes. The project from Nong Han to Phang Kon (36.58 km) comprises of three sub-sections, i.e. (i) Km 60+000 to Km 72+600; (ii) Km 83+098 to Km 94+748; and (iii) Km 100+248 to Km 116+048 and the project from Sakon Nakhon to Nakhon Phanom (33.26 km) will have one section from Km 180+450 to Km 213+800.

13. NH22 cuts through areas with flat to moderate slopes. The vicinity is predominantly agricultural in nature, which includes large areas of rice paddies and a number of plantations of eucalyptus, sugar cane and teak in Nong Han to Phang Kon. In Sakon Nakhon to Nakon Phanom, the types of plantations along the roadside include rice, corn, cassava, rubber trees, and eucalyptus trees.

14. There are also small restaurants and shops for handicrafts, fruits, and vegetables along the road. Identified sensitive receptors along the ROW of NH22 are 17 schools, 11 temples and churches, and one health center.

15. There is a total of 1,420 trees that may be affected by the widening of NH22. These tree species consist of teak, padauk, Gmelina and a number of perennial trees. Most of the teak trees were planted by DOH within the ROW to serve as ROW border. About 779 trees are found on the left side of the road while 641 trees are on the right side. These include one Yang Na tree and 10 trees of *Anisoptera costata Korth* within the ROW, which are common species in northeastern region of Thailand but are on the International Union on Conservation of Nature's (IUCN) Red List[2].

[2] The IUCN Red List of Threatened Species™ is the world's most comprehensive inventory of the **global** conservation status of plant and animal species.

16. There are no major rivers along the ROW. Creeks and canals have intermittent flow, primarily occurring during the rainy season only. Communities near the road section in Phan Na village at Km 88+960 reported occurrences of overflowing of the side drainage canals due to a weir that was built by the Irrigation Department that restricted the flow of water during the rainy season. However, flooding has not reached the road level.

17. **National Highway 23.** NH23 is in the south of the GMS East-West Economic Corridor (EWEC) and connects the provinces of Roi Et and Yasothon. The road widening will occur at two sub-sections, i.e. (i) Km 115+512 to Km 141+165 and (ii) Km 143+412 to Km 172+812. The road sections traverse 27 villages, 11 sub-districts, and 4 districts of Thawat Buri, Thung Khao Luang, Selaphum, and Mueang Yasothon.

18. The vicinity is characterized as flat, agricultural area. The highway traverses two rivers, namely, (i) Chi River which drains into the Khong River, a tributary of Mekong River, and (ii) Yang River, which drains into the Chi River. There are also some small creeks and irrigation canals. The project area is within the upper catchment of the Chi River basin and is not prone to flooding.

19. Based on the inventory of affected trees, there will be 175 trees that may be affected within the ROW in Roi Et and 284 trees in Yasothon. Most of these trees are Neem and Yang Na species. Big Yang trees can be found in Yasothon district such as near the Non Yang school, Bodindecha military camp, and outside the community temple in Ban Chuek. There are 28 trees of *Anisoptera costata Korth* and 273 trees of Yang Na which are both considered as endangered in the IUCN; 11 Siamese Rosewood and 20 Burmese Rosewood which are in the vulnerable category.

20. There are also small restaurants and shops for handicrafts, fruits, and vegetables along the road. Identified sensitive receptors in vicinity of the ROW of NH23 are 14 educational institutions, 4 temples, and one health center.

F. Environmental Impacts and Mitigation Measures

21. **Benefits of the Project.** The widening of NH22 and NH23 is expected to result to improved convenience, speed and safety on these roads and enable the highways to accommodate more traffic in the future. The project is expected to help promote development of economy, trade and industry and bring forth more investment and employment opportunities.

22. **Pre-Construction Activities to Mitigate Anticipated Impacts.** The project design team took into account the following considerations: (i) engineering soundness; (ii) traffic volume, (iii) community areas and road junctions, (iv) road safety, (v) flooding and drainage, (vi) cutting of trees, (vii) impacts on workers, (viii) stakeholder opinions and suggestions, (ix) health effects, and (x) environmental problems on water quality and air quality.

23. Impacts on Current Roadside Activities and Structures**.** There are shops, driveways, parking lots, and agricultural rice land within the ROW which would be affected by (i) loss of use of productive land inside the ROW; (ii) economic displacement on shops; and (iii) temporary impacts during construction on driveways and parking lots. The resettlement impacts are being assessed separately and a Resettlement Plan has been developed to ensure that impacts on affected persons are properly addressed.

24. Minimization of Trees to be Cut. The ROW of NH22 and NH23 will not traverse any ecologically sensitive area but trees will be cut within the ROW due to road widening. Among the

trees to be cut are Yang Na and Anisoptera costata Korth (Mersawa Kesat) which are in the endangered category of the IUCN as well as teak which is classified as Category A restricted timber under Thailand's Forest Act (1941). Information from the Provincial Forest Departments and from stakeholders during public consultations however indicates that Yang Na, Mersawa Kesat and teak are tree species common in northeastern Thailand. The Royal Forest Department reported that teak and Yang Na are famous as commercial tree species in almost all provinces in Thailand because these species can be grown fast. Teak in Thailand is found extensively in the north and stretched along the western border to the east (*Sumantakul & Sangkul*). Yang Na are commonly found in and around ricefields[3] and can be found in Thailand, Cambodia, Laos, Myanmar, Vietnam and in the Philippines (*FAO, 1985*)[4] The 2013 records of the Royal Forest Department indicate that there are about 25,098 rai or 4,016 hectares of teak plantations and 734 rai or 117 hectares of land with Yang Na that are grown throughout the 20 provinces in northeastern Thailand. There are also about 2,550 rai or 408 hectares where there is co-crop planting of teak and Yang Na trees.[5] Based on information gathered from the website of the Office of Environmental Protection (ONEP), there are 848.68 square kilometers (sq.km.) of forest plantations in Nakon Phanom; 436.36 sq km in Yasothon; 510.71 sq.km. in Roi Et; and 1,910.90 sq.km in Sakon Nakhon. In the eastern region where teak, Yang Na and Mersawa Kesat species are common, a total of 27,555.54 sq.km of forest plantation exists.[6]

25. The DOH considered the potential environmental impacts by ensuring that the widening of the highway is within the established ROW only. To determine the number of trees that will be affected, the DOH design team through the DOH District Offices conducted an inventory of trees within the ROW. Based on the requirements of the Royal Forest Department and the Forest Act, the DOH will submit the inventory of affected trees to the Provincial Forest Department to determine which tree will require cutting or conservation.

26. As part of the mitigation measures during the pre-construction phase, DOH updated the highway design by reducing the width of the road and median in certain road sections. The updated design (July 2017) reduced the number of affected trees along NH22 from 1,420 trees to 535 trees. At NH23, there are no changes in the number of affected trees because of limitations in the road ROW. Tree replacement activities will be initiated at the start of the construction works.

27. Animal Crossing. The typical design for NH23 road upgrade applies depressed median for lane divider which will not obstruct crossing of cows and buffalos which move from one side of the road to the other for food and agricultural use. The raised median in some sections, mainly the community areas, may create a physical divider to cattle but this should be minimal as those areas are mainly for commercial and residential uses. NH22, on the other hand, will have a raised median; but the approximately 10 centimeter rise is not anticipated to create a physical barrier to cows and buffalos crossing the road.

28. The impact of the road upgrade to animal access due to conflicts with traffic can be mitigated by provision of animal crossing signs to warn motorists of movement of animals on the road. Also in areas with seasonal streams, cattle herds can be redirected to cross the road by traveling along the creek. An information/education awareness program will be necessary to make

[3] The Thai Biodiesel Tree, greennet.or.th
[4] Trees Commonly Cultivated in Southeast Asia. Food and Agriculture Organization. www.fao.org
[5] Source: The Royal Forest Department Information Center, 2013
[6] http://chm-thai.onep.go.th/chm/ForestBio/Complexes-forest-area-provin.html. Date accessed: July 24, 2017

sure that the local people and owners of cattle exercise caution when animals are being herded to avoid hazard to road traffic.

29. Criteria for Location of Associated Facilities. The operation of construction camps, borrow areas, quarry sites and batching plants will generate a range of environmental and social impacts. The potential effects of borrow areas, quarry sites and batching plants are related to raw materials transport, slope instability, haphazard extraction, and borrow pit abandonment and impacts on public health and safety including noise, dust, and proliferation of mosquitoes causing vector diseases. Quarrying can have long term and permanent adverse impacts such as visual impairment (scarring), change in topography, consumption of resources, change in land use, increased susceptibility to erosion and siltation, and alteration of natural drainage patterns. There is also possible chance discovery of archaeologically significant items or sites during excavation of quarries and borrow pits.

30. A contractors' environmental management plan (CEMP) that includes specific mitigation to address environmental impacts of construction camps, off-site borrow pit, quarry, and asphalt or concrete batching plants, and other project facilities will be required from each contractor prior to start of civil works. The contractor will be required to include in the CEMP the cut and fill material requirements and sources of fill materials. Only authorized or permitted borrow pits and quarries should be used as sources of these materials. As a general rule, these facilities should not be located near waterways and drainage canals and should be at least 500 meters away from sensitive areas (i.e. residential communities, hospitals/health institutions, and schools).

31. **Environmental Impacts During Construction.** Most of the anticipated impacts during construction are short-term and have medium magnitude which suggests that change is detectable with moderate effect on the environment and social component. These impacts can be managed by adopting appropriate mitigation measures. Identified impacts include soil erosion which may affect adjacent agricultural land, drainage canals, irrigation channels, and waterways; traffic congestion and accidents; temporary restriction of access; nuisance from noise and vibration; release of dust and engine gas emissions; discharge of wastewater from construction camps; and community and occupational health and safety risks. Recommendations formulated in the EMP, its inclusion in the contractual framework, and an effective inspection of construction activities will reduce these risks to an acceptable level.

32. Removal of Trees. Considered as a moderate though long-term negative impact of the project during construction is the cutting of existing trees in the road ROW. There is a total of 994 affected trees at NH22 and NH23 based on inventory of the road ROW and after adjustments in the design of road median to further reduce the number of affected trees. Although most of the tree species are common, 27 trees are Mersawa Kesat and 276 are Yang Na trees. Both trees are in the IUCN Red List, thus, requiring special conservation measures. These tree species are popular sources of timber in Thailand and are grown in forest plantations.

33. Clearing of trees will be limited to areas within the ROW that are necessary based on the project's detailed design. The Forest Industry Organization (FIO), a state-owned enterprise, will cut the trees that are approved for removal by the Royal Forest Department. The FIO will undertake the tree removal process in close coordination with the DOH District Offices. Extra caution will be exercised during the tree removal activity to avoid damage to structures (houses, shops, fences, etc.) that are adjacent to where the trees will be felled as well as avoid any occupational and community hazard. The environment specialist of DOH or CSC will monitor and document the tree-cutting activities which will be reported in the SEMR.

34. At the outer portion of the road ROW, landscaping will be undertaken while replanting will be done in other appropriate locations agreed with the local authorities in coordination with the Royal Forest Department. In accordance with the design of the roads, the contractor will implement the landscaping and re-vegetation along the roadside alignment. The DOH District Office will monitor and assess the condition and effectiveness of project landscaping and replanting as well as implement remedial measures where appropriate by replacing dead or damaged vegetation during the commissioning phase. Detailed procedures to be observed during tree cutting will be stipulated in the CEMP to reflect the specific locations where trees will be felled based on the approved tree cutting clearance. The DOH will select shrubs and other medium-sized vegetation for landscaping. Large trees can become hazards to errant vehicles and as such can be a safety concern. Based on the DOH Code of Practice on planting on the road ROW, medium-sized perennial plants will be planted at approximately 30 meter spacing, depending on the highway architecture and availability of space. Perennial endemic species that can adapt to the topography and tropical climate of the area will be used. The perennial plants and shrubs must be of the same type for similar growth rate and ease in maintenance. For areas with raised median, the shrubs must not be higher than 0.8 meters to avoid obstructing the line of sight. In addition, the landscaping will be outside of the clear zone to avoid exposure of maintenance workers to vehicle traffic. Under no circumstances shall shrubs, trees or other landscaping materials be placed where it may interfere with highway safety or traffic visibility, including signs and other traffic control devices. In selecting the planting area, the bushes or shrubs should not be planted close enough to the road to avoid root systems from undermining or damaging the road structure.

35. The landscaping program will include regular maintenance to ensure that the plant's growth do not obstruct the view of signs or interfere with the sight distances of approaching traffic. Maintenance works include irrigation, removal, relocation, or pruning of plants to eliminate obstruction. The maintenance activities will be undertaken through the DOH District Offices.

36. In addition to landscaping along the road, the DOH will also assist the Royal Forest Department in replanting trees, specifically, the Yang Na, teak, and Mersawa Kesat species. The replanting program aims to compensate for the ecosystem services that will be affected by tree cutting on the road ROW and to assist in increasing forest cover in the northeastern provinces although the trees to be removed are not in natural forest areas.

37. The replanting activities will be undertaken through the Royal Forest Department, which is the Government organization mandated to implement replanting and reforestation programs. The Royal Forest Department has seed orchards and large nursery centers which can be tapped to provide seedlings and technical services on tree replanting.

38. At the start of the construction stage, the DOH together with the Provincial Forest Departments and ADB will survey areas for replanting in the vicinity of NH22 and NH23 such as sensitive receptor sites like schools and temples, recreational parks and other Government land. Consultations with these establishments and provincial authorities will be conducted with the Provincial Forest Departments who will provide technical support to DOH and the host establishment on the replanting program. The focus of the replanting program will be the endangered species of Yang Na and Mersawa Kesat as well as Teak which is an important species in Thailand. A total of 1,289 trees consisting of 699 Yang Na; 534 Teak; and 56 Mersawa Kesat trees will be replanted by the project. The tree replacement will be at a ratio of 1:2 to account for seedling survival. In case of seedling mortality, the contractor will be required to allocate budget for replacement of seedlings and maintenance until the end of the construction period when the seedling survival achieves a stable state.

39. The DOH will also support watershed replanting programs of the Royal Forest Department through participation in actual tree planting activities as part of DOH's Corporate Social Responsibility (CSR) program. The replanting areas will preferably be in watershed areas with low population pressure and grazing demand to ensure high survival rates of the tree species. These replanting sites will also be coordinated with the Provincial Governments to ensure that land use plans and possible land use conversion issues are taken into consideration.

40. Another moderate adverse impact of the project during construction is on noise. The operation of equipment such as jackhammer, soil compactor, and backhoe during road construction may cause nuisance to activities in nearby temples and residential communities. Along roads used for material transport, the average noise level may rise because of increased truck traffic. Based on the expected noise levels from construction equipment operation, noise levels of 75 dB(A) up to 90 dB(A) may be generated from the operation of construction equipment and vehicles. The affected area could reach approximately 100-meter radius of the construction area. The construction activities would have few fixed or constant construction sites since the concentration of the construction activities would generally move along the highway alignment as the work progresses. Construction periods longer than one month but less than 4 months are expected along the road widening sections.

41. At sites of the two major bridges at NH23, noise from construction activities would last about one year. However, these bridge sections are not areas where noise nuisance to settlements are a concern. At batching plants, noise is anticipated to exceed background noise levels by more than 5dB(A) due to associated vehicle movements and operation of plant equipment. As such, batching plant operation should be located at least 500 meters away from settlements and sensitive receptor areas.

42. Proposed mitigation measures to control noise during construction are outlined in the EMP. These measures include limiting the operation of noise generating equipment at night particularly in community areas, positioning stationary equipment that produce high noise levels as far as practical from sensitive receptors, provision of temporary walls or barriers around construction sites, and provision of noise suppression devices, when appropriate.

43. **Environmental Impacts During Operation.** The potential environmental impacts from the operation of the proposed road widening would include increased noise, vibration, air pollution, road accidents due to higher vehicle volume and speed, and soil erosion and flooding due to blocked drainage canals and poor condition of road shoulder. DOH will implement regular maintenance of NH22 and NH23 and will coordinate with the local governments and other concerned agencies to reduce the impacts during the operational phase.

44. Noise. The impact of noise during operation of the project to the immediate project area was estimated using the methodology described by the UK Department of Transport on Calculation of Road Traffic Noise (CRTN). The method predicts noise at a reception point from the road and uses the parameters such as road surface, traffic flow, speed of traffic, percentage of heavy vehicles/composition of traffic, road gradient, and mean speed. The existing and predicted traffic flows at three road segments: (i) NH22 in Sakon Nakon, (ii) NH22 in Nakon Phanom, and (iii) NH23 in Roi Et to Yasothon were used to model the noise during operation of the project. The without and with project scenarios were based on 2016 and forecasted 2040 vehicle traffic composition. The percentage of large vehicles at NH22 is projected to increase to 13.03% at NH22 in Sakon Nakon; to 11.39% at NH22 in Nakon Phanom; and to 11.89% at NH23 in Roi Et to Yasothon.

45. With the project and considering increased traffic movements, there is anticipated increase of 2.8 dB(A) at current noise levels at NH22 in Sakon Nakon; 5.6 dB(A) at NH22 in Nakon Phanom and 1.0 dBA at NH23 in Roi Et to Yasothon by year 2040. Primarily as consequence of the increase in projected traffic volume by year 2040 at NH22 in Sakon Nakon-Nakon Phanom section, noise level increase in this segment is high. In addition, the traffic growth in this section is predicted to carry more freight vehicles that produces higher noise levels than light passenger cars.

46. Given the limitations of the model a pragmatic approach is to recommend to the DOH the continuous conduct of noise level monitoring during the operation phase to validate model results and generate actual noise level results. Appropriate measures to mitigate traffic noise may be implemented as necessary should monitoring validate the modeling results in Sakon Nakhon.

47. Despite uncertainties and the limited data available for the model the preliminary results could be used as a management tool and guide the DOH and the local government units to manage noise levels in the future. It could be useful in managing the changes in land use, growth of communities and building of structures along the roads.

48. Road Accidents. The expansion of the traffic lanes at NH22 in Nong Han to Phang Kon would allow faster traffic but will potentially cause of serious accidents particularly at the road intersections at road number 2096, 2225, and 2239 and in front of schools. The road intersections in Sakon Nakhon to Nakon Phanom with road numbers 2132, 2018, and 2276 are also particularly important. There is also risk of accidents with cows/buffalos crossing the road in areas with grazing or agricultural land uses.

49. Road infrastructures such as pedestrian overpass in front of schools, clear warning signs and traffic signals will be needed to minimize road accidents. Traffic control staff may be necessary at certain times.

50. **Mitigation Measures and Monitoring Plan.** The EMP and monitoring program have been designed and outlined in the IEE and will need to be updated if there are significant changes in the project design and new information becomes available. The EMP and monitoring program will be included in the bid documents and each winning contractor will be required to prepare and submit a contractor's environmental management plan (CEMP) prior to start of construction. The CEMP will be based on the project EMP with details specific to each contract package. Apart from the mitigation measures and monitoring activities that each contractor is required to implement, CEMP will also include information on the location of associated project facilities such as quarries, borrow pits, batching plants, constructions, waste disposal sites, and cut and fill balance. In locating these associated project facilities, sensitive receptors should be avoided.

G. Public Consultation and Information Disclosure

51. Stakeholder consultations, facilitated by the DOH District Offices, were conducted in communities along NH22 and NH23 to present the proposed project and to gather feedback from stakeholders about their concerns and suggestions. A total of 480 participants representing various villages, schools, temples, and local government offices in the vicinity of the project roads attended the consultation meetings that were held from March 7 – 14, 2017. Informal interviews and meetings with local communities, business owners, community leaders, and local government officials supplemented these consultation meetings.

52. In general, the communities welcome the proposed road widening because of the benefits on accessibility, safer roads, and increased economic opportunities for the locality. The major issues that were raised by the stakeholders are: (i) provision of pedestrian overpass in front of schools and community areas; (ii) provision of adequate drainage; (iii) positioning the U-turn in areas readily accessible to communities; (iv) provision of street lighting, warning signs, traffic lights, and bus waiting areas; (v) minimize tree cutting; (vi) allow small shops with temporary sheds to continue operating at roadsides; (vii) allow rice farmers using the ROW to continue planting in 2017 while construction has not started yet.

53. As a follow-up to the public information disclosure and consultation activities, there will be subsequent public consultation activities to notify local communities, individuals, and other affected parties about the construction schedule, location of U-turns and pedestrian overpasses, temporary access restrictions, traffic management plans and cutting/removal of affected trees. The Project Management Unit (PMU) of the DOH, in coordination with the DOH District Offices, will spearhead these follow-up consultations.

54. The IEE and semi-annual environmental monitoring reports (SEMR) will be disclosed on ADB's website in accordance with ADB's SPS and Public Communications Policy.

H. Grievance Redress Mechanism

55. As a general policy, the DOH will work proactively towards preventing complaints through the implementation of impact mitigation measures and through community liaison activities that anticipate and address potential issues before they become grievances.

56. A grievance redress mechanism (GRM) will be established for the project to provide a systematic process for receiving, validating, and resolving complaints from affected people. The project's GRM will consist of a system of receiving, evaluating, and addressing affected people's (AP) grievances related to the project. The Project Engineer manages all matters related to the construction of the project and is the focal person for receiving and resolving complaints received from the public about project implementation. A complaint or issue may also be raised by the public through other existing modes of entry, which is then referred to the Project Engineer for immediate action. An Information Board visible to the community will be posted at the construction site to update the public about the ongoing project activities including the contact person and number to whom grievances could be raised. The steps for the GRM are outlined in this IEE.

57. **Conclusion and Recommendation.** The results of the IEE show that the proposed project will not result to significant adverse environmental impacts. Environmental mitigation measures have been designed as outlined in the EMP to address any adverse impacts during the various phases of project implementation. The EMP also presents the institutional responsibilities for implementing the mitigation measures. The IEE concludes that the design of the project combined with available information on affected environments is sufficient to identify the scope of potential environmental impacts of the project. Provided that significant changes to the project component do not occur at the detailed design phase and that new sensitive environmental or cultural resources are not determined, further detailed environmental impact assessment of the project is not required for submission to ADB.

58. In compliance with the requirements on the Forest Act 2484 (1941) and the 1968 law on the cutting of trees within the ROW of national highway, the DOH will report and submit to the Provincial Governor an inventory of trees prior to the start of construction activities. The procedure

outlined in the Forest Act will be followed to ensure that cutting of restricted trees is approved by the Royal Forest Department.

59. The IEE and EMP will be updated if there are significant changes in the project design and new information becomes available. The EMP, including the monitoring program will be included in the bid documents to require each contractor to prepare a CEMP and ensure the implementation of the mitigation measures that will address adverse environmental impacts.

I. INTRODUCTION

A. Project Concept and Rationale

60. The Government of the Kingdom of Thailand plans to improve sections of the existing national highways from single 2-lane carriageway to divided 4-lane carriageways. The project is in line with the directive from the Council of Ministers that assigned the Ministry of Transport (MOT), through the Department of Highways (DOH), to develop an action plan for the construction of national highways into four lanes across the regions in the country. The plan aims to provide road users with safe, convenient, and secure means of travel in accordance to international standards. In line with this, the DOH developed a feasibility study for the construction of additional lanes in 18 existing road networks. The DOH completed 3,538.60 kilometers, representing 67.14 percent of the target as of April 2016. There are still ongoing road widening projects covering about 658.37 kilometers while budget for 1,073.50 kilometers is still needed to complete the plan.

61. Two of the national highways which require widening to four lanes are the National Highway 22 (NH22) and National Highway 23 (NH23). The Government has requested the Asian Development Bank (ADB) for financing to implement the widening of NH22 and NH23 under the Greater Mekong Subregion (GMS) Highway Expansion Phase 2 project.

62. The widening of the national highways into four lanes is important because these roads provide connection to different regions of the country and between major cities and main towns. The highways also allow access to special economic zones and therefore will help promote development of economy, trade, and industry. Road widening will also accommodate anticipated future traffic growth.

63. Specifically, the proposed project aims to:

a) Increase convenience, speed and safety in the transport sector.
b) Expand the road infrastructure and ensure the development of efficient highway system that will accommodate more traffic.
c) Support economic development of the countryside and different regions through road connectivity.
d) Promote international trade and cooperation through development of efficient road infrastructures that are linked to other neighboring ASEAN countries.
e) Reduce traffic accidents.

64. The Ministry of Transport (MOT) is the Executing Agency and the Department of Highways (DOH) of MOT is the Implementing Agency. A Project Management Unit (PMU) will be established in DOH during project implementation until its turn-over to the DOH District Offices for regular maintenance and operation.

B. Methodology for Environmental Assessment

65. Using ADB's Rapid Environment Assessment Checklist for transport projects, the project is classified as Category B for environment and therefore requires an Initial Environmental Examination (IEE) based on ADB's Safeguard Policy Statement (SPS, 2009). The potential adverse environmental impacts are site-specific, largely reversible, and can be mitigated with an environmental management plan.

66. The ADB SPS (2009), ADB Operational Manual Section F1/BP, Public Communications Policy (ADB PCP, 2011), World Bank Environment, Health and Safety (EHS) Guidelines, and

relevant environmental laws and regulations of the Government of Thailand guided the preparation of the IEE. The information presented in the IEE report is based on the following:

a) site assessment and field visits from December 2016 to April 2017
b) environmental sampling in four stations through a third party environmental sampling team to establish the baseline environmental conditions in terms of ambient air quality (PM_{10}, TSP, SOx, NOx), noise levels, and vibration along NH22 and NH23
c) secondary data gathering from Provincial Offices of Natural Resources and Environment (PONRE), Provincial Forest Departments, and other Government agencies
d) Inventory of trees within the ROW by DOH District Offices to identify the tree species, size (diameter and height) and distance from the existing road
e) Survey of sensitive receptors such as schools, temples and churches, offices, and health institutions within 100 meters from the road
f) Information disclosure and public consultations from March 6 – 14, 2017 to inform the community about the proposed project and to gather their views, concerns and suggestions about the project implementation, including issues related to potential environmental impacts of the project to the community.
g) Informal interviews and meetings with stakeholders and local governments to gather available secondary information and validate environmental and social issues at the project sites.

67. The assessment focused on the existing environmental and socio-economic conditions at the project areas and the likely positive and significant negative impacts on the physical, biological and socio-economic environment. Mitigation measures were developed in the environmental management plan (EMP) to address potential impacts and risks of the subproject. Likewise, environmental monitoring and reporting, institutional arrangements, and capacity development measures to ensure the implementation of the EMP are outlined in the IEE.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. ADB's Environment Safeguards Policies

68. The environment safeguards requirements of ADB are presented in the following guidelines:

a) Safeguard Policy Statement (2009)
b) Operational Manual Section F1/BP[7] and
c) Public Communications Policy (PCP) 2011.

69. The environment safeguards requirement follows ADB's Strategy 2020[8], which emphasizes the pursuit of environmentally sustainable and inclusive economic growth for developing member countries (DMCs) and requires mitigation to address environmental and social impacts of projects. The ADB's Safeguards Policy Statement (SPS, 2009) governs the environmental and social safeguards of ADB's operations. When a project has been identified for ADB financing, it is screened and categorized to determine the following:

a) Significance of potential impacts or risks of the project to the environment
b) Level of assessment and institutional resources required to address the safeguard issues; and
c) Information disclosure and consultation requirements.

70. The Environmental Safeguard Requirements 1 (SR1) of the SPS outlines the requirements that borrowers/clients have to meet. These requirements include assessing impacts, planning and managing impact mitigations, preparing environmental assessment reports, disclosing information and undertaking stakeholder consultations, establishing a grievance redress mechanism, and monitoring and reporting. It also includes specific environmental safeguard requirements pertaining to biodiversity conservation and sustainable management of natural resources, pollution prevention and abatement, occupational and community health and safety, and conservation of physical cultural resources.

71. Through the use of environment screening checklists that have been developed by the ADB, the project is initially categorized for potential environmental impacts and risks. ADB assigns a proposed project to one of the following categories:

Category A – if a proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented; impacts may affect an area larger than the sites or facilities subject to physical works. A full-scale environmental impact assesses (EIA) including an environmental management plan (EMP) is required.

Category B – if a proposed project's potential environmental impacts are less adverse and fewer in number than those of category A projects; impacts are site-specific, few if any of them are irreversible, and impacts can be readily addressed through mitigation measures. An initial environmental examination (IEE), including an EMP is required.

Category C – if a proposed project is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.

[7] Operations Manual Bank Policies (BP) issued on 1 October 2013, based on ADB Safeguard Policy Statement, 2009.
[8] ADB. 2008. Strategy 2020: The Long-Term Framework of the Asian Development Bank 2008-2020. Manila.

Category FI – is assigned to projects that involve investment of ADB funds to or through a financial intermediary.

72. The category of the proposed project is determined by screening using the ADB's sector-specific Rapid Environmental Assessment (REA) checklist. The environmental categorization should be based on the most sensitive environmental component. For instance, if one component of the project has potential for significant adverse impacts, the entire project should be classified as Category A, even if all other components have no significant environmental impacts. If the most sensitive component falls under Category B, the project should be classified as Category B even if the other components are unlikely to have adverse environmental impacts. EIA Report is required for Category A projects and IEE Report for Category B projects. The EIA or IEE Reports should include the Environmental Management Plans (EMPs) that specify the proposed mitigating measures specific to a potential impact, the environmental monitoring requirements, institutional arrangements, and budget requirements.

73. ADB also requires public disclosure for Category A and B projects. As a Category B project, the draft IEE report of the project should be available to interested stakeholders before project approval and posted on the ADB's website upon Board approval of a project.

B. Legal and Institutional Framework on Environmental Management in Thailand

74. There are a number of applicable environmental laws and standards in Thailand that applies to road projects. This section presents these relevant environmental legislations, the requirements and processes involved in the evaluation and monitoring of the proposed project by the Government of Thailand (GOT).

1. Environmental Policy Framework

75. From 1961 to 1966, Thailand developed a series of five-year plans that provided the framework for national policy planning. It was in the Seventh Plan covering the period 1991-1996 where the Government declared its commitment to environmental conservation. The Seventh Plan, which was approved in August 1990, established the policy goals to sustainable economic development, equitable income distribution, and human resource development, including protection of the environment and natural resources. The environmental policy in Thailand, which was enacted in 1975 through the Improvement and Conservation of National Environmental Quality Act was repealed by the Enhancement and Conservation of National Environmental Quality Act of 1992. A number of other laws, which are closely associated with environmental policies, were also revised such as the Factory Act, Public Health Act, Hazardous Substances Act, and Energy Conservation Promotion Act.

76. The Enhancement and Conservation of National Environmental Quality Act of 1992 established the Pollution Control Committee, introduced a system of designated pollution control areas, set up the Environmental Fund, established uniform nationwide emission and discharge standards, encouraged participation of environmental non-government organizations (NGOs), strengthened the "polluter pays" principle, and increased the penalties for non-compliance.

2. Environmental Impact Assessment

77. The National Environmental Quality Act (NEQA) of B.E. 2535 (1992) deals with wide-ranging issues related to the enhancement and conservation of the environment of Thailand. The Ministry of Natural Resources and Environment (MONRE) has published a list of projects and

activities that could potentially produce adverse effects on natural resources, general environment, local communities and health for which assessments must be conducted. The EIA rules and guidelines are outlined in Thai Government Gazette dated 20 June B.E. 2555 (A.D. 2002). The Notification of MONRE in 1992 stipulates that an EIA report shall be carried out for roads or highways that pass through any of the following:

a) Wildlife sanctuaries and wildlife non-hunting areas
b) National parks
c) Class 2 watershed areas
d) Mangrove forest designated as National Forest Reserve
e) Coastal areas within 50 meters from the maximum sea level.

78. Under Section 44(3) of the Notification of Environmentally Protected Area and the MONRE Notification, the widening of the existing sections of NH22 and NH23 do not require an environmental clearance from the Office of Natural Resources and Environment Policy and Planning (ONEP) since the roads do not traverse ecologically sensitive areas.

79. An environmental checklist for each road section was prepared by the DOH as part of the report submitted for approval by Cabinet. The project was approved by Cabinet on October 19, 2016.

3. Forest Conservation and Cutting of Trees within the National Highway

80. The Forest Act (1941) regulates forest management and harvesting of forest products. The requirements on the cutting of trees in the ROW of national highway is stipulated in the B.E. 2511 (1968) law and regulation. When an organization plans to build, or extend a road, or if a part of the road will pass through forest area, national reserve forest or wildlife area, the DOH is required to inform the Royal Forest Department before a project is implemented. The DOH should submit a project description and the inventory of affected trees in the ROW. For restricted trees that are regulated under the Forest Act of 1941 and the Natural Reserve Forest Act of 1964, the cutting of trees is prohibited unless permission from the Royal Forest Department is secured.

81. Trees that are located in the ROW or area reserved for DOH in accordance to the Highway Act 1939 and Highway Act No. 2 (1954) are exempted from registering except for some type of trees whereby the Government through the Royal Forest Department should have a contract with a licensee or Forest Industry Organization.

82. There are two categories of restricted timber. Under Section 7 of the Forest Act (1941), teak and Yang trees that are grown anywhere in the country are timber classified under Category A: General Restriction. Cutting of these types of trees can be made upon granting of a license to a Forest Industry Organization appointed by the Minister. Other types of timber that are grown in the forest are restricted timbers.[9]

83. If the amount of wood is more than 5 cubic meters, the provincial DOH should coordinate with the provincial Forest Department and the local Forest Industry Organization in seeking permission from the Royal Forest Department. The permission to cut trees is issued by the Royal Forest Department to the Forest Industry Organization.

[9] Section 7 of the Forest Act stipulates that "Teak and Yang grown anywhere in the Kingdom shall be timber in Category A. Other timbers grown in the forest are restricted timbers in which category shall be subject to the provisions of the Royal Decree. Category B: Strict Restriction is timber that is rare or reserved timber in which logging thereof is restricted, except where a special permission is granted by the Minister"

84. The following are the procedures in securing the permission to cut trees in the road ROW:

a) The DOH District Office will submit the request for permission to remove trees within the road ROW together with the inventory of trees to the District Chief which then reviews and endorses the application to the Governor.
b) The Governor will endorse the application the local Forest Resource Management Office (Provincial Forest Department) for evaluation.
c) The Royal Forest Department approves or disapproves the application to remove trees in the ROW.
d) If approved, a Working Group is constituted in accordance with an order of the Royal Forest Department No. 1843/2554 dated 2 June 2011. The Working Group composed of the Provincial Forest Department, DOH District Office, and Forest Industry Organization will survey the area and recommend on trees permitted to be cut.
e) The result of the survey of the Working Group is submitted to the Province.
f) The Forest Industry Organization is informed about the approval of the application and receives the license to cut the trees after payment of the prescribed fees.

85. The tree cutting is done by the Forest Industry Organization (FIO), a state-owned enterprise, under the Ministry of Natural Resources and Environment. The FIO conducts logging in government-granted logging concessions in natural forests as well as in cutting trees outside of protected forest areas such as within road ROW. Under the Forest Act (1941), a royalty rate for timber is determined based on the type of tree to be cut and size. The FIO as licensee or concessionaire is allowed to use any equipment, instrument, beast, vehicle or machine for the cutting of trees.

4. Public Participation

86. The process of engaging the public in the planning and development of the projects and listening to public opinion are embodied in the National Environmental Quality Act 2535 (2007) and the Regulations of the Office of the Prime Minister 2548. The Constitution of the Kingdom of Thailand B.E. 2550 (2005) has a provision that requires the participation and involvement of citizens in the development process so that the people can benefit fully from a proposed development project and reduce negative effects to a minimum.

87. The Constitution of the Kingdom of Thailand B.E. 2550 (2005) mentioned the right of citizens to be informed and to encourage active participation in the development of projects. The provisions are specifically mentioned in the following sections of the Constitution:

a) Article 56 stipulates that a person shall be entitled to receive notice and access data or information in possession of public authorities, enterprises, government agencies or local government, unless the disclosure of information will affect stability, public safety or interest of the state.

b) Section 57 stipulates that a person shall be entitled to information, explanations and reasons from the government, enterprises, government agencies or local government prior to the implementation of any project or activity that may have an impact on the environment, health, quality of life of the people. Stakeholders are entitled to express their opinion to relevant authorities.

c) Article 66 stipulates that persons together as a community, local communities or indigenous communities are entitled to the conservation and protection or traditional local knowledge, art and culture, including use of natural resources and biodiversity to achieve balanced and sustainable development.

d) Article 67 stipulates that the rights of individuals to engage with the state and the community in the conservation, maintenance, and protection of natural resources and biodiversity towards the attainment of normal living conditions without adversely affecting the environment and contributing to hazards to health, welfare or quality of life of the people.

5. Other Applicable Environmental Guidelines and Standards

88. The ONEP published the "Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016" which contains a series of government guidelines stemming from the NEQA and deals specifically with water pollution, air pollution, noise and vibration, solid waste and night soil, and hazardous waste.

89. **Air Quality.** The ambient air quality standards of Thailand is stipulated in the Notification of National Environmental Board (NEB) No. 10, B.E. 2538 (1995)[10] and Notification of NEB No. 24, B.E. 2547 (2004)[11] based on the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992). Subsequent amendments were issued in 2007, 2009, and 2010 which were published in the Royal Government Gazette. The ambient air quality standards applicable to the project are shown in Table 1.

Table 1: Ambient Air Quality Standards

Pollutants	Average	Standard
Carbon monoxide (CO)	1 hr	Not exceed 30 ppm (32.4 mg/m^3)
	8 hr	Not exceed 9 ppm (10.26 mg/m^3)
Nitrogen Dioxide (NO_2)	1 hr	Not exceed 0.17 ppm (0.32 mg/m^3)
	1 year	Not exceed 0.03 ppm (0.057 mg/m^3)
Sulfur Dioxide (SO_2)	24 hr	Not exceed 0.12 ppm (0.30 mg/m^3)
	1 hr	Not exceed 0.3 ppm (780 µg/m^3)
TSP (Particulate Matter Ø <100µm)	24 hr	Not exceed 0.33 mg/m^3
	1 year	Not exceed 0.10 mg/m^3
PM-10 (Particulate Matter Ø <10µm)	24 hr	Not exceed 0.12 mg/m^3
	1 year	Not exceed 0.05 mg/m^3
PM-2.5 (Particulate Matter Ø <2.5µm)	24 hr	Not exceed 0.05 mg/m^3
	1 year	Not exceed 0.025 mg/m^3

Notes:
1. Short term average standard (1, 8 and 24 hrs) is to prevent acute effect on human health
2. Long term average standard (1 month and 1 year) is to prevent long-term or chronic effect on human health.

Sources:
a) Notification of the National Environment Board - No. 10, B.E. 2538 (1995), No. 24, B.E. 2547 (2004), No. 28, B.E. 2550 (2007), No. 33, B.E. 2552 (2009), No. 36, B.E. 2553 (2010).
b) Thailand Board of Investment Guide on Environmental Regulations, 12/19/2014

90. **Noise Standards.** Project noise levels should satisfy the country standards and the internationally accepted guideline values of the WB/IFC Environment Health and Safety (EHS)

[10] Published in the Royal Government Gazette No. 112 Part 52, dated 25 May B.E. 2538 (1995).
[11] Published in the Royal Government Gazette No. 121 Special Part 104D, dated 22 September B.E. 2547 (2004).

adopted by ADB SPS. When the national standards are less stringent than internationally recognized guideline values, then the more stringent values are applied to assess the impacts of the project during all phases.

91. The EHS guideline values for noise in areas with residential, institutional or educational facilities stipulates that one-hour noise levels, $L_{Aeq_{1\text{-}hr}}$, should not exceed 45 dBA at nighttime (22:00 – 07:00) and 55 dBA at daytime (07:00 – 22:00). The EHS noise guidelines also stipulate that noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location. Noise prevention and mitigation measures are necessary where the predicted or measured noise impacts from a project exceed the applicable EHS noise level guidelines in areas where there are sensitive receptors.

92. The noise standards of Thailand are stipulated in the Notification of Environmental Board No. 15 B.E. 2540 (1997) under the Conservation and Enhancement of National Environmental Quality Act B.E. 2535 (1992) and Notification of Pollution Control Department on the Calculation of Noise Level, dated August 11, B.E. 2540 (1997). Sound level must be measured using a sound level meter conforming with International Electro-technical Commission (IEC) standards IEC 60804 or IEC 61672. The project will need to comply with the noise standard for Annoyance Noise[12] and maximum increase in noise level from the project should in any case be lower than 10 dB(A) under Thai regulations.

93. The national standard for noise in Thailand is less stringent than the EHS guideline values hence for this project, the EHS noise guideline values are adopted to enable the project to comply with ADB SPS and international standards. By complying with EHS guideline values, the project will also be compliant with Thai noise standards.

94. The comparison of the noise standards in Thailand and the EHS guideline values are shown in Table 2.

Table 2: Ambient Noise Standards

Ambient Noise	Thailand Standard[(a)]	EHS Guidelines[(b)]
Maximum Sound Level (Lmax)[13]	≤ 115 dB(A)	45 dBA (nighttime) 55 dBA (daytime)
A-weighted Equivalent Continuous Sound Level (Leq) 24 hours	≤ 70 dB(A)	-
Maximum increase in noise level	10 dBA	3 dBA

Sources:
(a) Notification of Environmental Board No. 15 B.E. 2540 (1997), Conservation and Enhancement of National Environmental Quality Act B.E. 2535 (1992) and Notification of Pollution Control Department on the Calculation of Noise Level, dated August 11, B.E. 2540 (1997)
(b) Noise Management (1.7) – Environmental, Health and Safety (EHS) General Guidelines. IFC/World Bank

95. Notification of the Department of Land Transport (1984) also established the standard noise level from transport vehicles such as buses and trucks. MONRE issued in 1992 the Notification on Noise Level Standard of Vehicles which established the standard noise level from

[12] Annoyance Noise means noise levels being measured outside a project site are generated from the operation of the project with interference. The noise level is higher from the background noise level, and exceeds the value specified in the notification.

[13] Maximum sound level – refers to the maximum noise level measured as dB(A) outside the site, which occurs at any time during measurement

vehicles and the prescribed noise measurement procedures for each type of vehicle. The maximum noise level must not exceed 100 dBA at a distance of 0.5 meter and 85 dBA at a distance of 7.5 meter.

96. **Vibration.** The Government imposes vibration standards for the protection of buildings as prescribed in Table 3.

Table 3: Vibration Standards for Protection of Impacts on Buildings

Building Type	Area	Frequency (Hertz)	Velocity (mm/s)	
			Vibration Case 1	Vibration Case 2
1	1.1 Foundation or ground floor of building	f ≤ 10	20	
		10<f≤50	0.5f+15	
		50<f≤100	0.2f+30	
		f>100	50	
	1.2 Top floor of building	every	40*	10*
	1.3 Each building floor	every	20**	10**
2	2.1 Foundation or ground floor of building	f≤10	5	-
		10<f≤50	0.25f+2.5	
		50<f≤100	0.1f+10	
		f>100	20	
	2.2 Top floor of building	every	15*	5*
	2.3 Each building floor	every	20**	10**
3	3.1 Foundation or ground floor of building	f≤10	3	-
		10<f≤50	0.125f+1.75	
		50<f≤100	0.04f+6	
		f>100	10	
	3.2 Top floor of building	every	8*	2.5*
	3.3 Each building floor	every	20**	10**

Sources:
a) Notification of the National Environment Board, No. 37, B.E. 2553 (2010), dated 26 April B.E. 2553 (2010), which was published in the Royal Government Gazette Vol. 127 Special Part 69D, dated 2 June BE. 2553 (2010).
b) Thailand Board of Investment Guide on Environmental Regulations, 12/19/2014

97. **Water Pollution Control.** The regulation on waste dumping into watercourses (1913) and Navigation Act (1992) are intended to prevent the effects of pollution on aquatic resources. Under these regulations, it is forbidden to dump rocks, gravel, silt, mud, debris, solid waste, sewage, oil and chemicals in public watercourses which are used for navigation and for other purposes. The Royal Irrigation Act (1942) also prohibits the dumping of wastes and toxic effluents into irrigation canals.

98. **Solid and Hazardous Waste Management.** The Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) defines waste as “refuse, garbage, filth, dirt, wastewater, polluted air, polluting substances or any other hazardous substances which are discharged or originated from point sources of pollution, including residues, sediments or remainders of such matters, either in the solid, liquid or gaseous state.” Wastes that may be produced by the project during construction phase are characterized as (i) domestic solid waste from construction camps, and (ii) hazardous wastes such as used oil, empty paint containers, and cleaning fluids.

III. DESCRIPTION OF THE PROJECT

99. The proposed Greater Mekong Subregion (GMS) Highway Expansion Phase 2 project is a supplement to the fully completed Phase 1 loan from the Asian Development Bank (ADB) covering upgrades to Highway 12 from Phitsanulok to Lom Sak (105 km) and Highway 359 from Phanom Sarakham to Sa Kaeo (73 km).

100. The Government has requested the ADB for financing to implement the widening from 2-lane carriageway to divided 4-lane carriageway of sections of National Highway 22 from Nong Han to Phang Kon (36.58 km) and from Sakon Nakhon to Nakhon Phanom (33.26 km) and sections of National Highway 23 (NH23) from Roi Et to Yasothon (55.06 km). The project will be implemented by the MOT through the DOH as implementing agency.

A. Project Location and Components

101. NH22 and NH23 are located in northeastern Thailand and are within the GMS East-West Economic Corridor (EWEC). The NH22 ends at the Thai border in Nakhon Phanom where the Third Mekong International Bridge links Thailand with Thakek District of Khammouane Province in Lao PDR. NH22 and the Nakhon Phanom border are used as the main freight transportation route between Thailand and Guangxi Zhuang Autonomous region, PRC through Lao PDR and Viet Nam. The NH23 ends at Ubon Ratchathani Province, which also shares a border with Lao PDR through a NH217 road link to Champassak Province in Lao PDR. Both NH22 and NH23 are designed to be important routes of international freight between the neighboring countries.

1. National Highway 22

102. The road upgrade at NH22 will cover a total distance of 69.84 km. There are two major road sections in NH22 which will require widening to four lanes. Road section 1 from Nong Han to Phang Kon (36.58 km) is under the administrative jurisdiction of DOH Sakon Nakhon Highway District 2 and will involve three sub-sections in Sawang Daen Din District. These upgrades are at: (i) Km 60+000 – Km 72+600; (ii) Km 83+098 – Km 94+748; and (iii) Km 100+248 - Km 116+048.

103. The road section 2 from Sakon Nakhon to Nakhon Phanom (33.26 km) at Km 180+450 – Km 213+800 is under the jurisdiction of DOH Sakon Nakhon Highway District 1 and DOH Nakhon Phanom Highway District.

104. The road upgrades at Nong Han to Phang Kon will traverse 22 villages, 11 sub-districts, and two sub-districts of Sawang Daen Din and Phang Kon. The section in Sakon Nakhon to Nakon Phanom will cut through 15 villages, 7 sub-districts, and 4 districts in the provinces of Sakon Nakhon and Nakon Phanom. The administrative areas of these road sections are presented in Table 4 while Figure 4 presents the map of NH22 and the sections to be upgraded.

Table 4: Administrative Areas of NH22 Upgrading

Province	District	Sub-district	Village	Chainage	
Nong Han to Phang Kon (36.58)					
Sakon Nakhon[1]	Sawang Daen Din	Bong Tai	Ban Ku Chik	60+250	61+175
		Kho Tai	Ban Nasam Boom	60+250	61+175

Province	District	Sub-district	Village	Chainage	
		Bong Tai	Ban Chum Chai	64+700	65+150
		Nong Luang	Ban Nong Yan Chin	64+700	65+750
		Ban Tai	Ban Tai	68+650	69+214
		Sawang Daen Din	Ban Dong Sawan	80+575	82+725
		Sai Mun	Ban Nong Kun	82+725	84+100
		Sai Mun	Ban Sai Mun	84+100	85+825
		Sai Mun	Ban Kham Mek	85+825	87+000
		Phan Na	Ban Ma	87+000	88+475
		Phan Na	Ban Phan Na	88+475	90+000
		Phan Na	Ban Muang Thong	90+000	91+300
		Phan Na	Ban Man	91+300	92+000
		That Thong	Ban Duea	92+000	92+800
		Waeng	Ban Dong Khueang	92+800	97+890
	Phang Khon	Muang Khai	Ban Pha Khao	98+500	99+250
		Muang Khai	Ban Muang Khai	99+250	100+233
		Muang Khai	Ban Dong	100+233	101+050
		Muang Khai	Ban Ang	101+050	101+527
		Muang Khai	Ban Muang Kam	101+806	102+500
		Muang Khai	Ban Kham Charoen	102+500	103+800
		Phang Khon	Ban Sang Khui	103+800	104+899
Sakon Nakhon to Nakhon Phanom (33.26 km)					
Sakon Nakhon[2]	Mueang Sakon Nakhon	Tha Rae	Ban Tha Rae	169+970	173+000
		Tha Rae	Ban Nong Bua Thong	173+000	175+000
	Phon Na Kaeo	Na Kaeo	Ban Thepnim It	175+400	181+000
	Kusuman	Na Pho	Ban Na Pho Noi	181+000	184+000
		Na Pho	Ban Na Pho	184+000	186+500
		Kusuman	Ban Kusuman	186+500	194+000
		Phothisan	Ban Non Rung Rueang	194+800	196+400
		Phothisan	Ban Niramai	196+400	198+490
Nakhon Phanom[3]	Mueang Nakhon Phanom	Wang Ta Mua	Chok Amnuay	200+150	200+650
		Wang Ta Mua	Non Chom Phu	204+400	205+010
		Wang Ta Mua	Nong Saeng	206+650	207+675
		Wang Ta Mua	Wang Muang	207+675	208+115

Province	District	Sub-district	Village	Chainage	
		Wang Ta Mua	Wang Ta Mua	209+050	209+980
		Wang Ta Mua	Porn Charoen	209+050	209+980
		Kurukhu	Ban Nong Ya	213+900	214+650

Notes:
1. Under the administrative jurisdiction of DOH Sakon Nakhon 2 District Office in Sawang Daen Din.
2. Under the administrative jurisdiction of DOH Sakon Nakhon 1 District Office in Kusuman.
3. Under the administrative jurisdiction of DOH Nakhon Phanom District Office in Pla Pak.

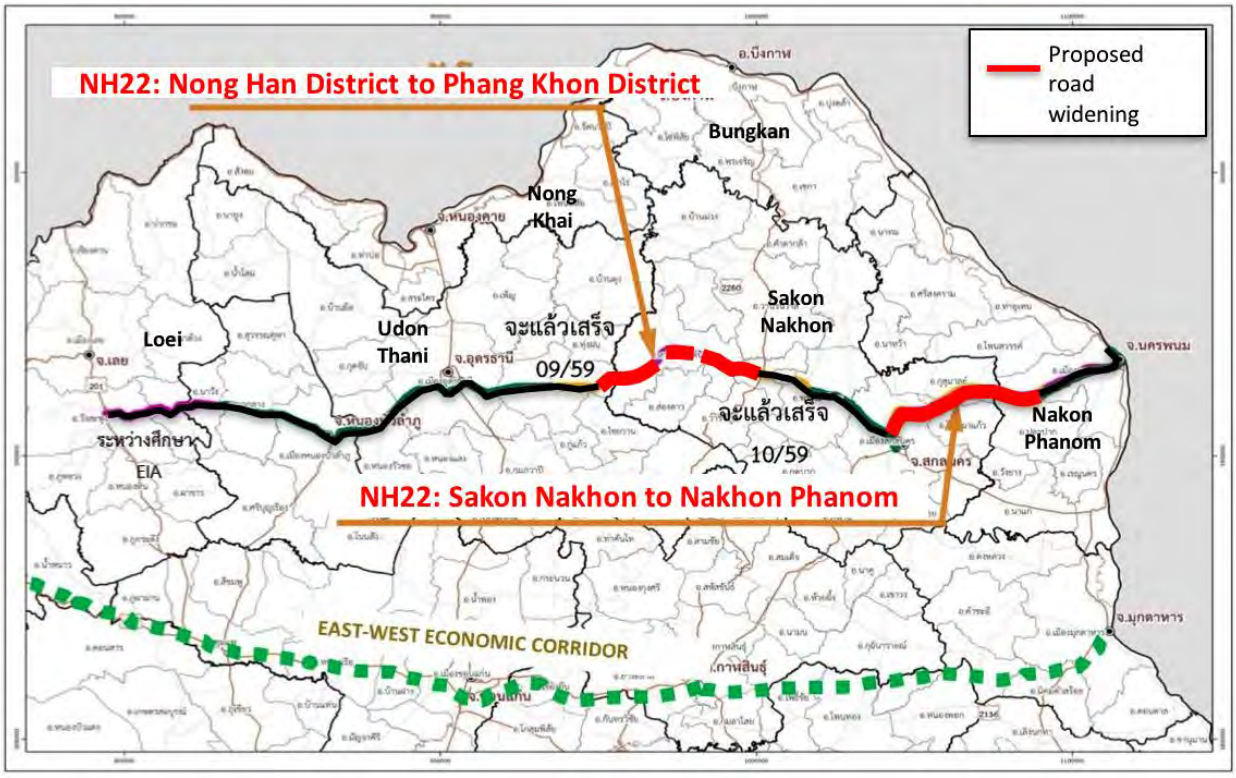

Figure 4: National Highway 22 showing the sections for road widening

105. The NH22 has a ROW of 60 meters, which was acquired through a Royal Decree in 1967. All proposed improvement works at NH22 will be located within the existing 60-meter wide ROW, with central depressed median of 8 meters. In community areas, there will be raised median of 5.10-meter width. The road surface will be asphaltic concrete with 10-centimeter thickness.

<u>Nong Han to Phang Kon (36.58 km)</u>

106. The Nong Han to Phang Kon alignment is located along Highway 15 in eastern Thailand which links the provinces of Sakon Nakhon and Udon Thani. Road surface will be asphaltic concrete. The construction of the additional lanes will require about 2.5 meter-high embankment to align with the level of the existing road.

107. The proposed central median in Nong Han to Phang Kon will be 5.1 meters wide elevated/raised median. Each lane width will be 3.5 meters and shoulder width will be 2.5 meters. To avoid cutting of trees at Km 69+100 to Km 72+600, the raised median width will be reduced to

2.2 meters. There will be a total of 16 U-turns in this section. Figure 5 presents the design of the raised median while Figure 6 shows the typical design of the U-turn.

108. There will be 25 bridges and 15 box culverts that will be constructed along the NH22 alignment. The locations of these infrastructures are summarized in Table 5.

Table 5: Locations of Bridges and Box Culvert at Nong Han – Phang Kon

Location of Bridge / Box Culvert	Number
A. Bridges	
Km 60+000 – Km 72+600	4
Km 81+100 – Km 93+450	10
Km 94+968 – Km 104+700	11
Total Bridges	**25**
B. Box Culvert	
Km 60+000 – Km 72+600	2
Km 81+100 – Km 93+450	9
Km 94+968 – Km 104+700	4
Total Box Culverts	**15**

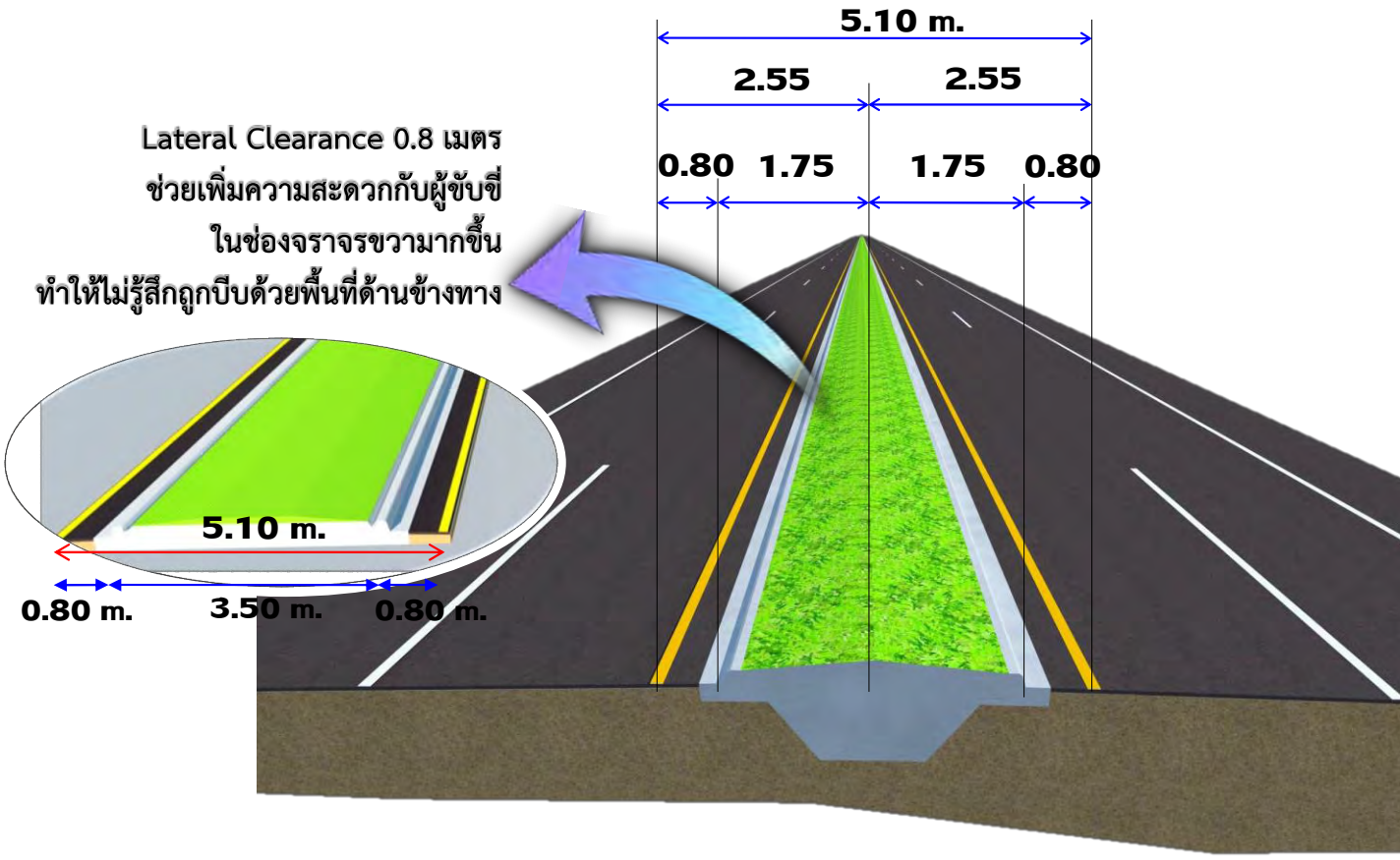

Figure 5: Design of Raised Median

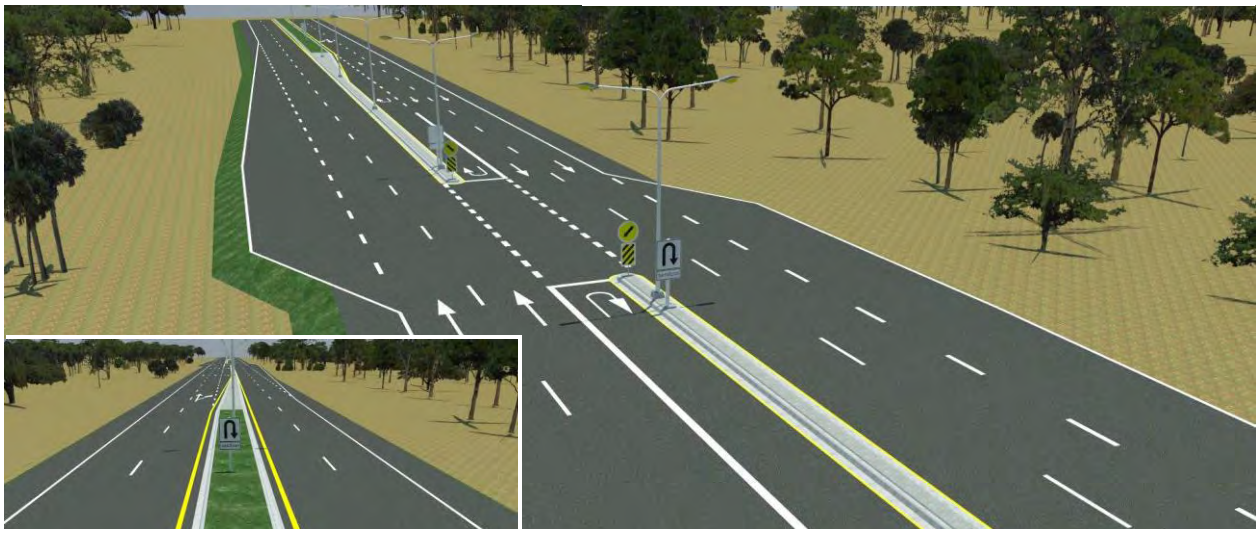

Figure 6: Typical Design of U-Turn

Sakon Nakhon to Nakhon Phanon (33.26 km)

109. The second road section of NH22 is from Sakon Nakhon to Nakhon Phanon province from Km 180+450 – Km 213+800, which covers a total distance of 33.26 km. The road widening project is about 20 km away from the Third Thai Mekong International Friendship Bridge at the Thailand border with Laos PDR. An additional one lane will be constructed on both sides of the road except at the beginning in Kusuman sub-district where the road widening for additional two lanes will be on the left side. The proposed road will be backfilled to about 1.5-meter-high to align with the current elevation of the existing road. The proposed roadway will include side drains and raised central median to replace the current painted median. The design of the U-turn and raised median will be the same as the section in Nong Han – Phang Kon.

2. National Highway 23

110. National Highway 23 (NH23) is in the south of the GMS East-West Economic Corridor (EWEC). The road section for upgrading traverses the provinces of Roi Et and Yasothon and will cover a total distance of 55.06 km. The road upgrades at NH23 will traverse 27 villages, 11 sub-districts, and 4 districts of Thawat Buri, Thung Khao Luang, Selaphum, and Mueang Yasothon. Figure 7 presents the location of the NH23 while Table 6 outlines the administrative areas covered by the project.

Table 6: Administrative Areas at NH23 Upgrading

Province	District	Sub-district	Village	Chainage	
Roi Et to Selaphum (25.657 km)					
Roi Et	Thawat Buri	Niwet	Pratu Chai	115+512	116+749
			Nikom	116+749	120+612
			Niwet	120+612	125+312
		Um Mao	Um Mao	125+312	126+112

Province	District	Sub-district	Village	Chainage	
		Phaisan	Fangdaeng	126+112	127+912
			Tha Bo	127+912	128+812
			Don Wua	128+812	129+912
			Hua Bo	129+912	131+612
	Thung Khao Luang	Thung Khao Luang	Wai Noi	131-+612	135+312
			Wai Leum	135+312	138+112
		Maba	Tha Sabaeng	138+112	139+137
	Selaphum	Klang	Tha Khai	139+137	139+412
			Klang (Municipal)	139+412	142+212
Selaphum to Yasothon (29.4 km)					
		Khwan Meaung	Selaphum	142+212	142+412
		Khwao1	Non Yang	151+762	153+652
Yasothon	Mueang Yasothon	Doet	Ban Mai Chumphon	153+552	157+062
			Ban Kham Daeng	157+062	159+112
			Ban Chuak	159+112	161+012
			Ban Doet	161+012	163+832
			Ban Nam Pho	163+832	164+912
		Du Thung	Ban Du Thung	164+912	165+862
			Ban Kham Bon	165+862	166+742
			Ban Nhong Sang	166+742	168+462
		Samran	Ban Nong 1 Tum	168+462	170+012
			Ban Bak	170+012	172+112
			Ban Chiang Wang	172+112	173+312
			Ban Samran	173+312	175+527

Notes:
1. Km115+512 to Km 141+169 is under the administrative jurisdiction of Roi Et DOH District Office.
2. Km 143+412 to Km 172+812 is under the administrative jurisdiction of Yasothon DOH District Office (Ard Samat)

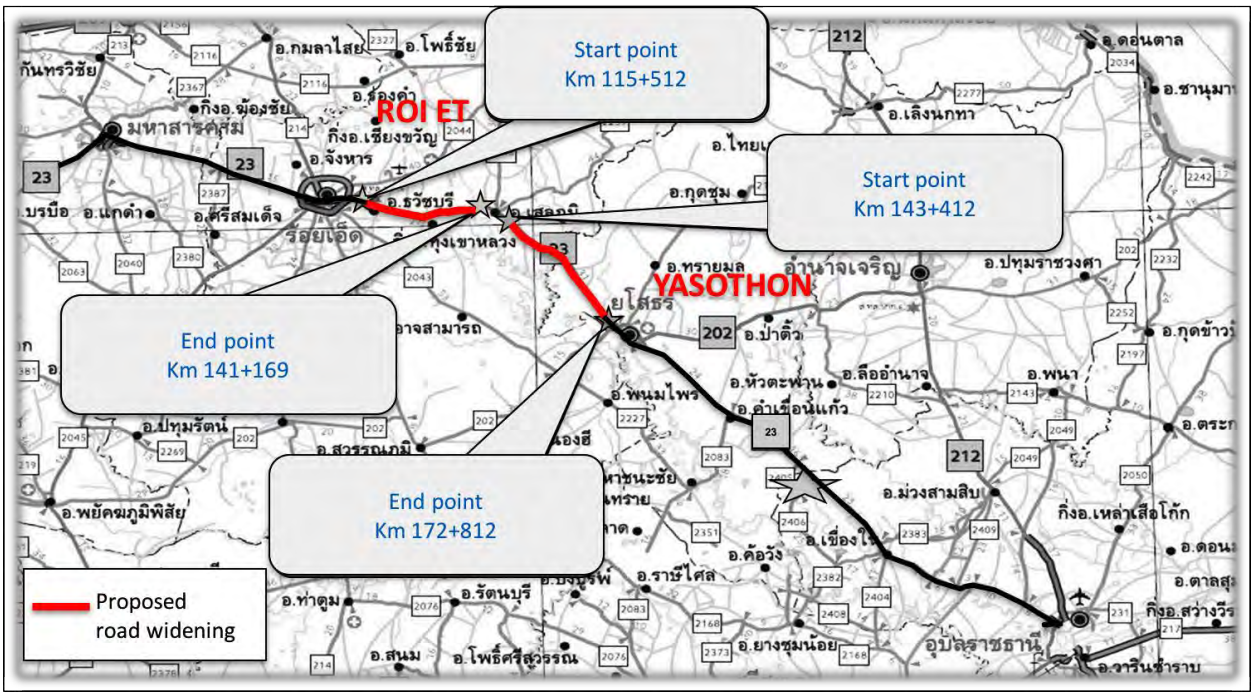

Figure 7: National Highway 23 showing sections for road widening

111. The road right-of-way (ROW) at NH23 is 60 meters which was acquired through a Royal Decree in 1968. The road improvement at NH23 will also involve the provision of 10-meter wide depressed central median, widening of the existing bridges across Chi River and Yang River and other small drainage crossings and provision of side drains on both sides of the road. Embankments will be constructed by filling to a height of about 1.2 meters from existing ground level to align with existing road elevation. Road sections within the town centers are already four lanes and are not part of the road widening project.

112.

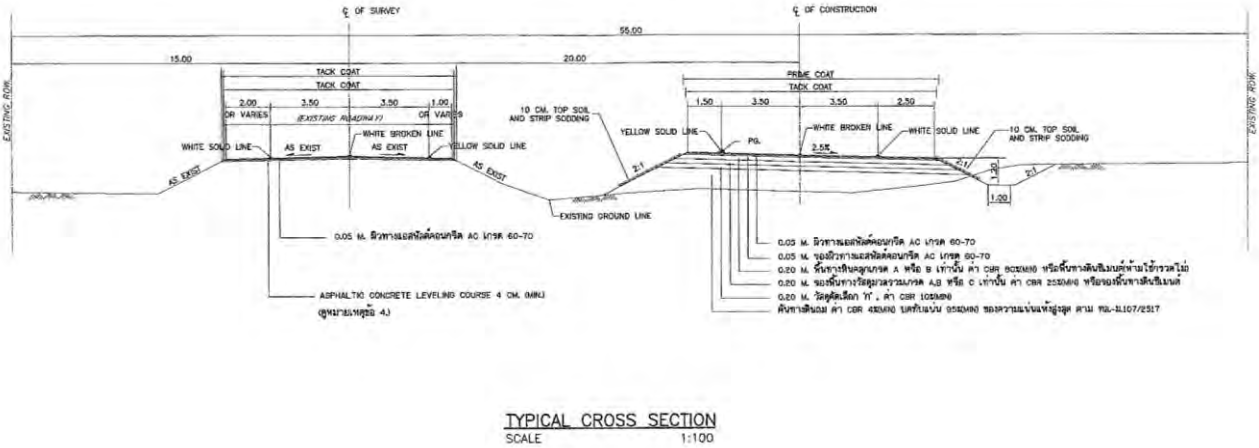

Figure 8: Typical cross-section of NH23 showing the depressed median

B. Design Considerations

113. The design of NH22 and NH23 upgrades will follow the geometric design standard for national highways as outlined in Table 7.

Table 7: Geometric Design Standards for National Highways

Design Parameters	Design Standard
AADT (cars per day)	>8,000
Design speed (km/hr) • Flat Road • Hilly Road • Mountainous Road	 90 – 110 80 – 110 70 - 90
Maximum Slope • Flat Road • Hilly Road • Mountainous Road	 4 6 6
Width of traffic lane (meter)	At least 7 m per direction
Shoulder width (meter)	LT 2.50 – 3.00 RT 1.00 – 1.50
Width of Bridge Surface	11.00 (minimum)
Right-of-Way Width (meter)	60 – 80
Maximum Elevation	10%

C. Associated Project Facilities

114. Associated project facilities are borrow pits, quarries, batching plants, disposal sites and construction camps. These associated facilities will be identified by the contractor as part of the tender documents while appropriate contractors' environmental management plans (CEMP) will be required from the contractors to avoid adverse impacts when locating and operating these facilities.

115. Depending on the cut and fill balance computation that will be developed during the detailed design, the contractor will be required to identify Government-approved sources of materials for the project. Based on initial estimates at NH23, there are more fill requirements for the project for the earth embankment than cut requirements. The roadway excavation volume for NH23 is estimated at 103,220 cubic meters while the embankment volume requirement is 924,845 cubic meters.

116. Disposal sites of sub-grades, base course layers and asphalt pavement to be removed from certain sections of the road will be transported to DOH reserve areas which are open areas owned by the DOH along the existing highways. These reserve areas are managed by the DOH District Offices. In accordance with the regular maintenance activities, the DOH District Offices reuse the sub-grades, base course layers and asphalt pavement disposed at the reserved areas for backfilling and embankment during rehabilitation and maintenance of road sections.

D. Project Activities, Implementation Schedule and Cost Estimates

117. The road improvement project will involve the following activities: (i) construction of additional two lanes to result to a 4-lane carriageway in sections of NH22 and NH23, including widening of existing bridges; (ii) provision of depressed or elevated central median to provide

physical separation; (iii) provision of side drains on both sides of the highway; and (iv) surfacing with asphalt concrete pavement. All proposed road improvements would be constructed within the 60-meter road right-of-way (ROW) that was established through Royal Decrees.

118. The widening of NH22 and NH23 will be undertaken simultaneously from 2018 to 2020. The implementation schedule and estimated costs are presented in Table 8.

Table 8: Implementation Schedule and Costs

Road Section	Distance (km)	Implementation Schedule	Estimated Cost
National Highway 22			
Nong Han – Phang Kon	36.58 km	2018 - 2020	2,300 million Baht
Sakon Nakhon – Nakon Phanom	33.26 km	2018 - 2020	1,978 million Baht
National Highway 23			
Roi Et - Yasothon	55.06 km	2018 - 2020	2,530 million Baht

IV. DESCRIPTION OF THE ENVIRONMENT

119. Thailand is located in the tropical area between latitudes 5º37'N to 20º27'N and longitudes 97º22'E to 105º37'E. The country covers a total area of 513,115 square kilometers.[14] It is bounded on the north by Myanmar and Lao PDR; on the east by Lao PDR, Cambodia, and the Gulf of Thailand; on the south by Malaysia; and on the west by Myanmar and the Andaman Sea. The proposed project will be located at the northeastern region of Thailand. The following sections describe the existing condition in the vicinity of the road alignments of NH22 and NH23.

A. Existing Condition in the Vicinity of NH22

120. NH22 is located in the north of the GMS East-West Economic Corridor (EWEC) in the northeast region of Thailand. The existing NH22 has a total distance of 316.38 km and traverses the provinces of Loei, Udon Thani, Sakon Nakhon, and Nakhon Phanom. About 214.71 km of NH22 have been widened to four lanes in 2016. As part of the project, the remaining length of 67.942 kilometers will be widened into four lane carriageways, of which 36.58 km are located in the provinces of Nong Han to Phang Kon which is under the administrative jurisdiction of DOH Sakon Nakhon Highway District 2. The 33.26 km traverses Sakon Nakhon to Nakhon Phanom is under the jurisdiction of DOH Sakon Nakhon Highway District 1 and DOH Nakhon Phanom District.

1. Nong Han to Phang Kon

121. The section of NH22 from Nong Han to Phang Kon (Km 60+000 to Km 104+700) is the main route that connects to the provinces of Udon Thani and Sakon Nakhon. The highway is strategically located and serves as an important international corridor that provides logistic support in the region. The NH22 is part of the Asian Highway No. 15 (AH15) that connects to the City of Thakek, Lao People's Democratic Republic and the Vinh province, Socialist Republic of Vietnam.

122. The Nong Han – Phang Kon alignment and immediate vicinity (about 100 meters from the road) include 14 schools and 6 temples. The hospitals and health centers are primarily in the town centers and are not within the affected areas of the road widening project. The vicinity is predominantly agricultural in nature which includes large areas of rice paddies and a number of plantations of eucalyptus, sugar cane, and teak. Small shops for handicrafts, fruits and vegetables can be found along the road in Nong Kong Village.

123. An inventory of trees within the ROW was conducted by the Sakon Nakhon Highway District 2. The inventory showed a total of 1,420 trees within the 60-meter ROW, consisting of teak, padauk and gmelina and a number of perennial trees. Most of the teak trees were planted by DOH on the side of the road to serve as ROW border and road landscaping. There are also DOH reserve areas near the road which serves as staging area of construction materials and disposal area for pavement materials removed from roads during maintenance activities. The reserve areas which are still not being used are planted with trees by DOH to prevent encroachment.

[14] Source: http://www.tmd.go.th

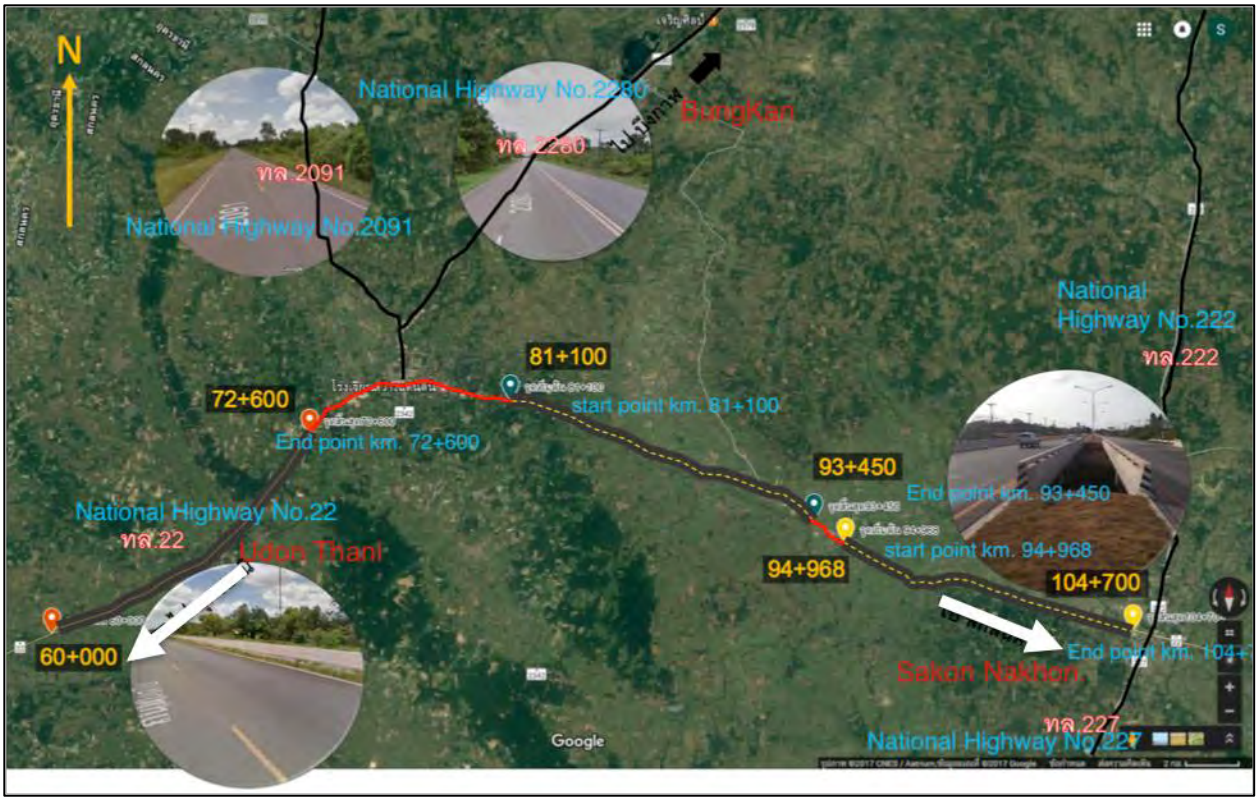

Figure 9: Location of Three Sections along NH22 in Nong Han to Phang Kon for Road Widening

124. There are no major rivers along the Nong Han to Phang Kon alignment. Creeks and canals have intermittent flow, primarily occurring during the rainy season only. Communities near the road section in Phan Na Village (km 88+960) reported overflowing of existing side canals due to irrigation weirs that were built by the Irrigation Department. However, the flood waters do not reach the level of the road. Based on observation, the side canals also need to be cleared of vegetation to improve flow of water in the canals.

125. There are no protected, ecologically or culturally sensitive areas within the ROW itself. The nearest protected area is the Phu Pha Lek National Park which is located about 30 km from the road.

Start of road widening in Nong Han

Open side drain in Phan Na Village is clogged with vegetation and reportedly swell during heavy rains

DOH reserve area in Nong Yan Chin Village

Teak trees planted by DOH along the road

Shops along the road

Existing road condition

Figure 10: Existing Condition at NH22 (Nong Han to Phang Kon)

2. Sakon Nakhon to Nakhon Phanom

126. The road section in Sakon Nakhon to Nakon Phanom is an existing two-lane undivided carriageway with a width of 7 meters and 1.5-meter shoulder. The existing road is asphalt-paved.

127. Topographic conditions along the Sakon Nakhon – Nakhon Phanon alignment is generally flat without significant slopes. As observed, most of the trees within the alignment consist of teak, majority of which were planted by DOH to prevent people from encroaching into the ROW.

128. In the vicinity of the alignment are areas for residential communities, poultry farm, vegetable farms, and a solar farm. There are no associated residential or related structures within the ROW itself, except for driveways and some temporary sheds of vendors. By the roadside are mostly agricultural areas with community areas scattered lightly at Km 93+000 – Km 100+000 and densely at Km 65+000 – Km 69+000; Km 102+000 – Km 106-600; and Km 107+755 – Km 110+000.

129. Types of plantations along the road include rice, corn, cassava, rubber trees, and eucalyptus trees. Agricultural production was noted to be highly mechanized. There are some cow/buffalo crossing signs which were found along the highway inasmuch as livestock raising is one of the means of livelihood of the villagers.

130. There are no major rivers but only small streams that have intermittent flow, primarily occurring during the wet season only. Bridges for irrigation channels or drainage canals were found along the alignment. There are also no declared protected, ecologically or culturally sensitive areas within the ROW.

Figure 11: Location of Section along NH22 in Sakon Nakhon to Nakon Phanom

Start of road widening in Kusuman sub-district

Trees and temporary shed of vendors along the ROW

Animal crossing sign along the road

A DOH reserve area in Kusuman sub-district

A dry creek between Kusuman and Pla Pak sub-districts

Typical condition of the road and adjacent areas

Figure 12: Existing Condition at National Highway 22 (Sakon Nakhon – Nakhon Phanom)

B. Existing Condition in the Vicinity of NH23

131. The National Highway 23 (NH23) is in the south of the GMS East-West Economic Corridor (EWEC) (Figure 13). The highway traverses the provinces of Nakhon Sawan, Phetchabun, Chaiyaphum, Khon Kaen, Makasarakham, Roi Et, Yasothon, and Ubon Ratchathani. NH23 has a total length of 667.07 km, of which 295.82 km has been constructed as four-lane highway while construction for 5.0 km length of the highway is still ongoing. NH23 serves a main thoroughfare between Mahasarakham – Roi Et – Yasothon – Ubon Ratchathani. It also connects central northeastern area and lower northeastern area to the East-West Economic Corridor.

132. The road section for upgrading traverses the provinces of Roi Et and Yasothon and the districts of Thawatchai, Tungkaoluang, Selaphum and Ard Samat. In general, the vicinity is characterized as flat, agricultural area. By the roadside are mostly rice paddies with community areas scattered lightly along Km 119+500 – Km 131+200 and Km 143+600 – Km 145+600, and densely along Km 137+400 – Km 140+400 and Km 160+800 – Km 171+800.

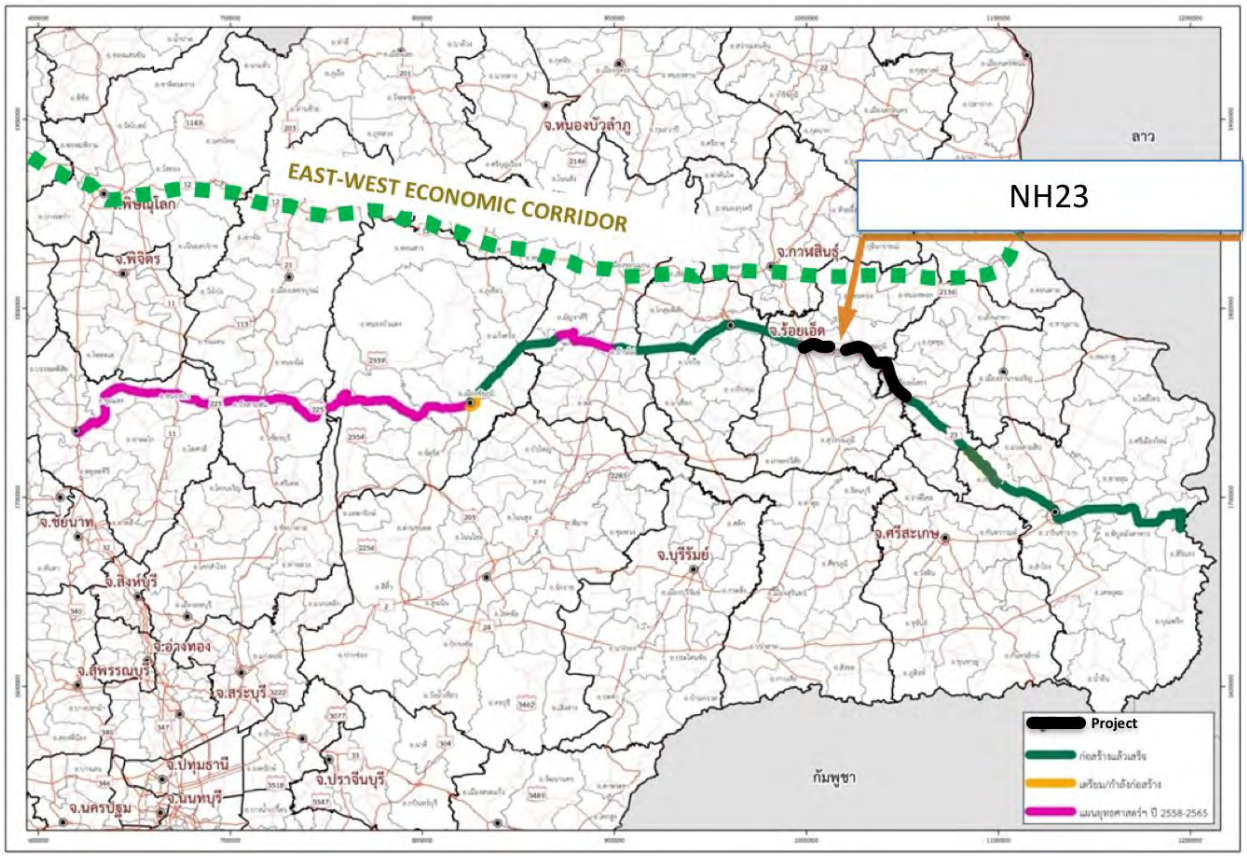

Figure 13: Location of Sections along NH23 in Roi Et to Yasothon

133. The existing road is asphalt-paved with two-lanes. The road has a total width of 7 meters, with 1.5-meter shoulder on both sides. The average ROW is 60 – 70 meters wide (30 / 30-40).

134. Within the ROW of the proposed project are 15 villages in Roi Et and 12 villages in Yasothon. In the vicinity are about 15 school sites, 4 temples, one health center, and 3 Government institutions (office, police station, and science center). The hospitals and health

centers are in the town centers and are not within the ROW of the road widening project. There are also road sections where buffalo/carabao and cows cross as evidenced by warning signs for animal crossings. These are in the areas in the vicinity of paddy fields. The stakeholders reported that cow/buffalo raising and rice production are primary means of livelihood in the villages.

135. The highway traverses two major rivers, namely, (i) Chi River that drains into the Khong River, a tributary of Mekong River, and (ii) Yang River, which drains into the Chi River. There are also some small creeks and irrigation canals where drainage crossings will be provided. The project area is within the upper catchment of the Chi River and is not prone to flooding, except in areas where there are clogged canals.

136. Within the ROW are trees mostly consisting of Neem and Yang Na trees. An inventory of trees within the alignment was provided by the DOH district offices which listed 175 trees within Roi Et District and 284 trees within Yasothon District. Big Yang Na trees can be found in Yasothon district such as near the Non Yang school, Bodindecha military camp, and outside the community forest temple in Ban Chuek.

137. There are no identified protected, ecologically or culturally sensitive areas within the ROW itself.

Agricultural land beside the road

Shops and vegetation along the road

Bridge across the Chi River

Yang Na trees in Ban Non Yang

Nonyang School along the road in Roi Et

A village road intersection with NH23

Figure 14: Existing condition at NH23

C. Sensitive Receptors

138. Sensitive receptors were identified within 100 meter from the ROW of NH22 and NH23. These sensitive receptors include schools, hospitals / health centers, temples and churches, and other Government institutions that may be affected by increased dust, noise and vibration from the construction and operation of the highways.

139. A total of 17 schools, 11 temples/churches, and one hospital were noted as sensitive receptors along NH22. Most of the educational institutions (14 schools) are located in the communities along the Nong Yan – Phang Kon section. Along the Sakon Nakhon – Nakon Phanom section are 3 schools, 6 temples (including two Catholic Churches) and one health center. The major hospital can be found at the town center. Tables 9 and 10 list down the sensitive receptors in the vicinity of sections of NH22 that will be upgraded.

Table 9: Sensitive Receptors in the Vicinity of NH22 (Nong Yan – Phang Kon)

Sensitive Receptor	Location	Kilometer	Left / Right
A. School			
1. Ku Chik-Nasomboon School	Kho Tau sub-district, Sawang Daen Din District, Sakon Nakhon	61+000	Right
2. Sakol Technical Vocational College	Bong Tai sub-district, Sawang Daen Din District, Sakon Nakhon	61+950	Left
3. Nongluangsuksa School	Nong Luang sub-district, Sawang Daen Din District, Sakon Nakhon	66+400	Right
4. Barntaienakonwitaya School	Ban Tai sub-district, Sawang Daen Din District, Sakon Nakhon	69+300	Left
5. Sawang Daen Din School	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	78+000	Right
6. Triam Udom Suksa School of the Northeast	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	78+900	Right

Sensitive Receptor	Location	Kilometer	Left / Right
7. Mari Phithak Sawang Daen Din School	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	80+000	Left
8. Technology Sawang Daen Din School	Sawang Daen Din sub-district, Sawang Daen Din district, Sakon Nakhon	80+400	Left
9. Dong Sawan Wittaya School	Dong Sawan, Na Klang District, Nong Bua Lam Phu	81+950	Left
10. Ban Sai Mun School	Sai Mun sub-district, Sai Mun District, Yasothon	84+350	Right
11. Ban Siri Pattana School	Nam Om sub-district, Kho Wang District, Yasothon	89+600	Left
12. Don Khuaen Learning Center	Waeng sub-district, Sawang Daen Din district, Sakon Nakhon	94+300	Right
13. Ban Sang Du Don Khueang Community School	Waeng sub-district, Sawang Daen Din, Sakon Nakhon	95+250	Right
14. Ban Pha Khao Phon Phaeng School	Phang Khon, Amphoe Phang Khon, Chang Wat, Sakon Nakhon	98+500	Right
B. Temples			
1. Wat Charoen Chai	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	60+650	Left
2. Wat Pa Chum Chai Saeng Phan	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	64+800	Left
3. Wat Pa Ban Ngon	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	73+800	Right
4. Wat Sawang Phumdon	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	78+000	Right
5. Wat Non Sawan	Sawang Daen Din sub-district, Sawang Daen Din District, Sakon Nakhon	80+250	Right

Table 10: Sensitive Receptors in the Vicinity of NH22 (Sakon Nakhon – Nakon Phanom)

Sensitive Receptor	Kilometer	Left / Right
A. Schools		
1. Ban Chok Amnuai School	199+900	Left
2. Ban Nong Saeng School	207+350	Left
3. Ban Nong Ya Sai School	214+000	Right
B. Temples / Churches		
1. Wat None Chompoo Buddhist Temple	205+050	Left
2. Wat Ban Nong Saeng Buddhist Temple	207+150	Left
3. Saint Andrew Church, None Chompoo VIllage	207+700	Left
4. Wat Wang Ta Mua Buddhist Temple	209+600	Right
5. Catholic Church Nong Ya Sai	214+000	Right
6. Wat Nong Ya Sai Buddhist Temple	214+470	Left
C. Hospitals/Health Centers		
1. Wang Ta Mua Hospital	200+000	Left

140. A total of 14 schools, 4 temples, and one health center were found along NH23. Table 11 outlines the sensitive receptors at NH23.

Table 11: Sensitive Receptors in the Vicinity of NH23

Sensitive Receptor	Kilometer	Left / Right
A. School		
1. Banphatuchai School	116+850	Left
2. Roi Et College of Agriculture and Technology	118+800	Left
3. Roi Et Vocational College	119+100	Left
4. Thawatburi Wittayacom School	119+400	Left
5. Roi Et School for the Deaf	119+750	Left
6. Thawatbuti Wittayacom School	120+350	Left
7. Scout camp of Phaya Chai	120+350	Right
8. Thawatburi School	120+600	Left
9. Ummout School	125+525	Right
10. Roi Et Special Education Center	126+000	Left
11. Banthakrai School	159+100	Right
12. Selaphumwittayasan School	140+325	Right
13. Selaphumwittayakom School	141+400	Left
14. Selaphum School	141+800	Left
B. Temple		
1. Ekasatbumlung Temple	120+700	Left
2. Kosolrangsarid Temple	125+450	Right
3. Ban Wailum Temple	136+050	Right
4. Selaphumwanaram Temple	140+975	Left
C. Hospital/Health Center		
1. Thawatburi Health Center	120+345	Right

D. Topography

141. Thailand is naturally divided into four topographic regions: (i) the North; (ii) the Central Plain or Chao Phraya River basin; (iii) the Northeast or the Korat Plateau; and (iv) the South or Southern Isthmus. The northeastern region of Thailand is a high level plain called the northeast Korat plateau. The northeastern area is a vast plateau tilted towards the southeast and drains into the Mekong River which forms the eastern boundary between Thailand and Lao PDR. The northwest-southeast oriented Phu Phan ridge in the northeastern portion separates the region into two basins. One large high-level plain is in the west and another is smaller and slopes towards the east.

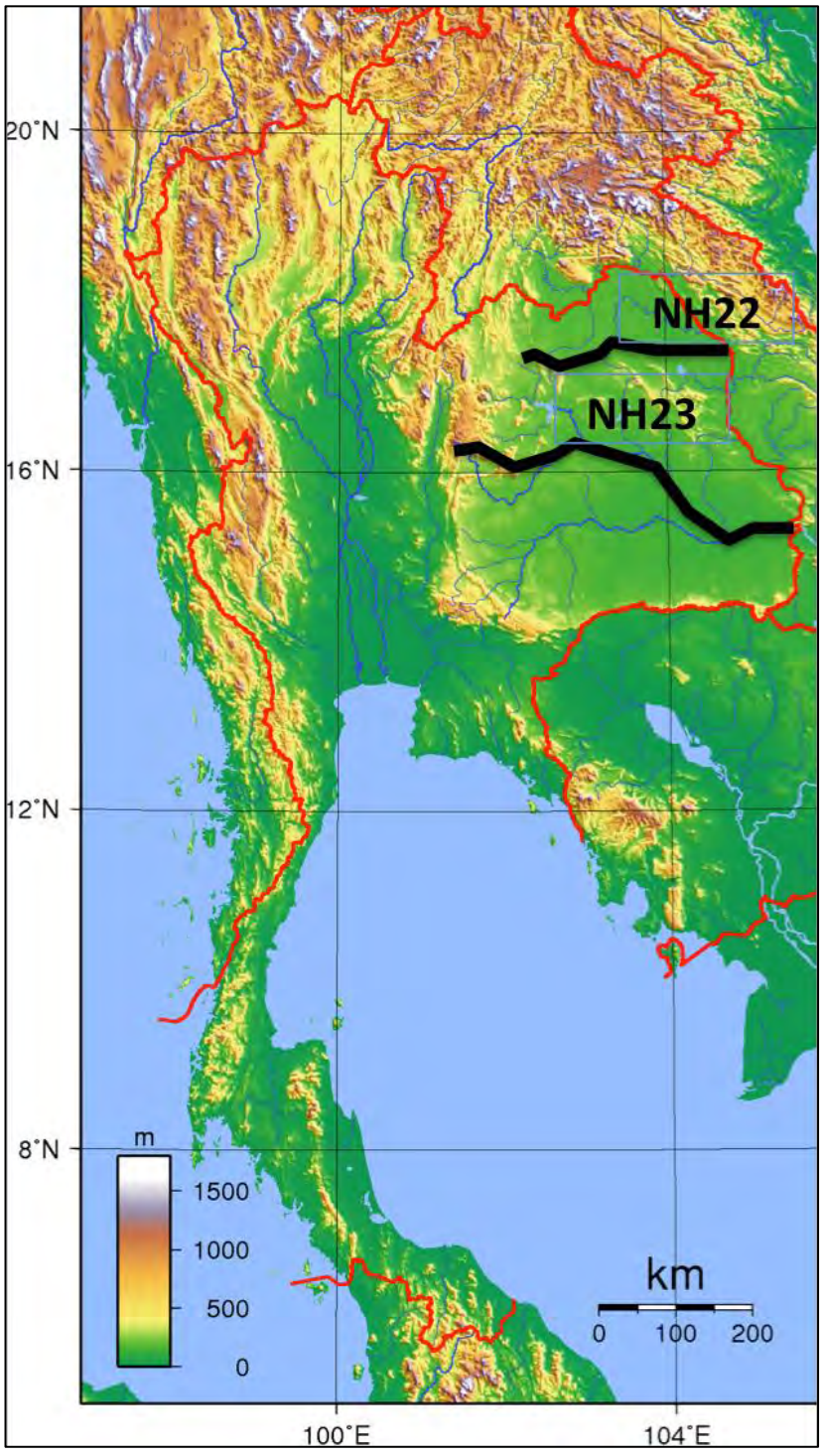

Figure 15: Topographic Map

Base Map Source: Sadalmelik https://commons.wikimedia.org/w/index.php?curid=2222946

142. NH22 and NH23 cut through areas with flat to moderate slopes which are in the geographic and physiographic unit of northeastern Thailand. This unit has an area of about 17,000 square kilometers and consists of the Khorat Plateau and its western fringe. The Khorat Plateau is a broad, nearly flat saucer shaped-basin formed by Mesozoic sedimentary rocks of the Kohrat series. It is divided into two subsidiary basins by the central ridge of the Phu Pha

Mountains. Elevations of the plateau range from 130 to 200 meters above sea level, and locally the mountains reach an elevation of about 700 meters.

143. The project area is in the plateau and has flat and moderate slopes downwards to the direction of Mekong River on the northeast. Higher elevation is found in the northeastern areas of Phu Luang and Phu Kradueng.

E. Geology and Soils

144. The geological formation of Thailand consists of rocks ranging in age from Precambrian to Quaternary. The Precambrian rocks can be found in the north, upper west, east, lower and southern parts of the country. More than 95 percent of northeastern Thailand is underlain by 4,800 meter thick Khorat Series of generally flat conglomerate, sandstone, shale, and evaporates. These sedimentary rocks, which form the Khorat Plateau, are partly covered by tertiary volcanic flows and quaternary alluvium.

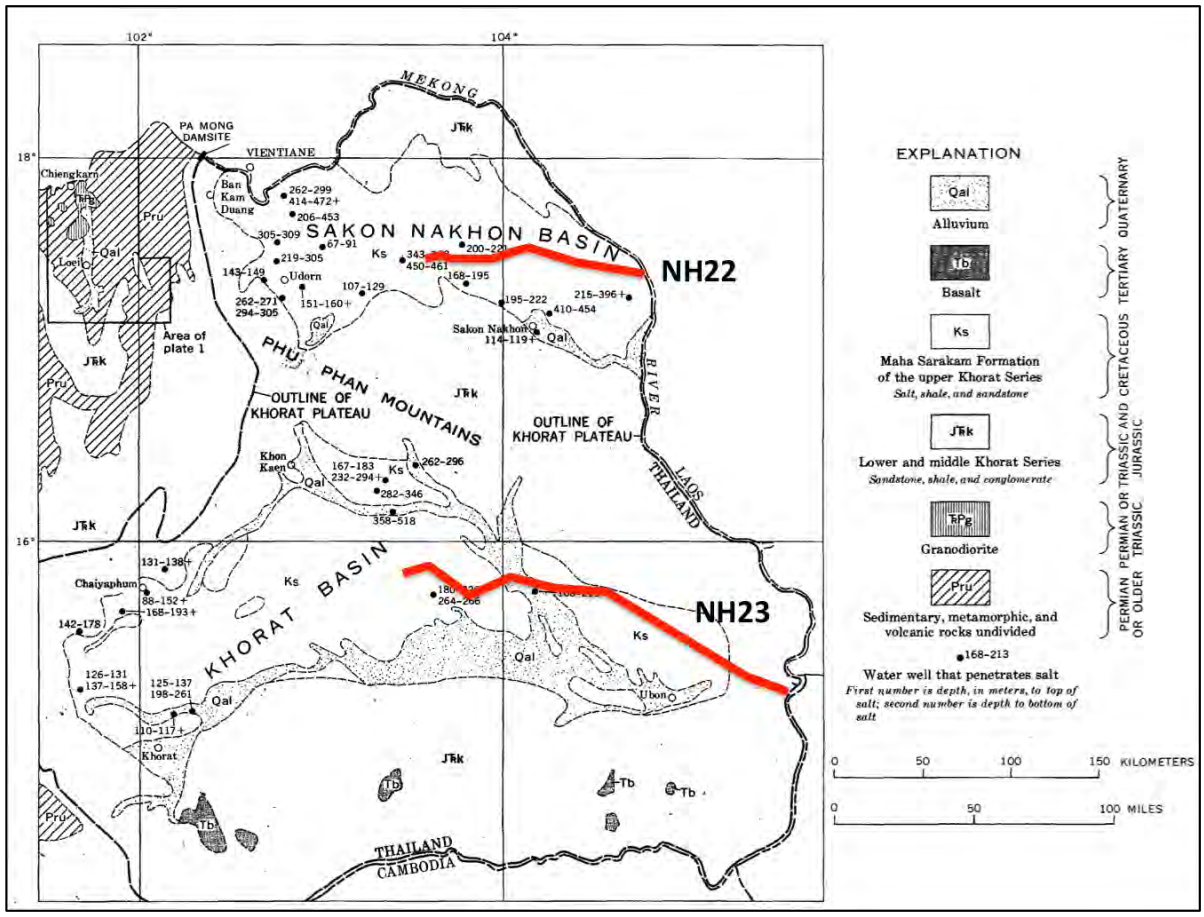

Figure 16: Geology of Northeastern Thailand

Base Map Source: Mineral Investigations in Northeastern Thailand, Geological Survey Professional Paper 618, Jacobson, et.al., U.S. Geological Survey, Royal Thai Department of Mineral Resources. 1969

145. There are no known active faults in the project area based on the fault mapping developed by the Department of Mineral Resources in Figure 17. The nearest active fault is the Uttaradit fault Zone which is approximately 115 kilometer-long, northeast trending. It is distinct and

characterized by straight scarps along the Nam Nan River near Nam Pat District. Based on satellite image and field data gathered by the Department of Mineral resources, the fault is likely to extend to northern Lao PDR, where few earthquakes with magnitude of about Mw 3.0 were recorded. The fault forms a prominent northwest-facing escarpment, the base of which is marked by a very sharp bedrock-alluvium contact, and crossing young alluvial deposit.

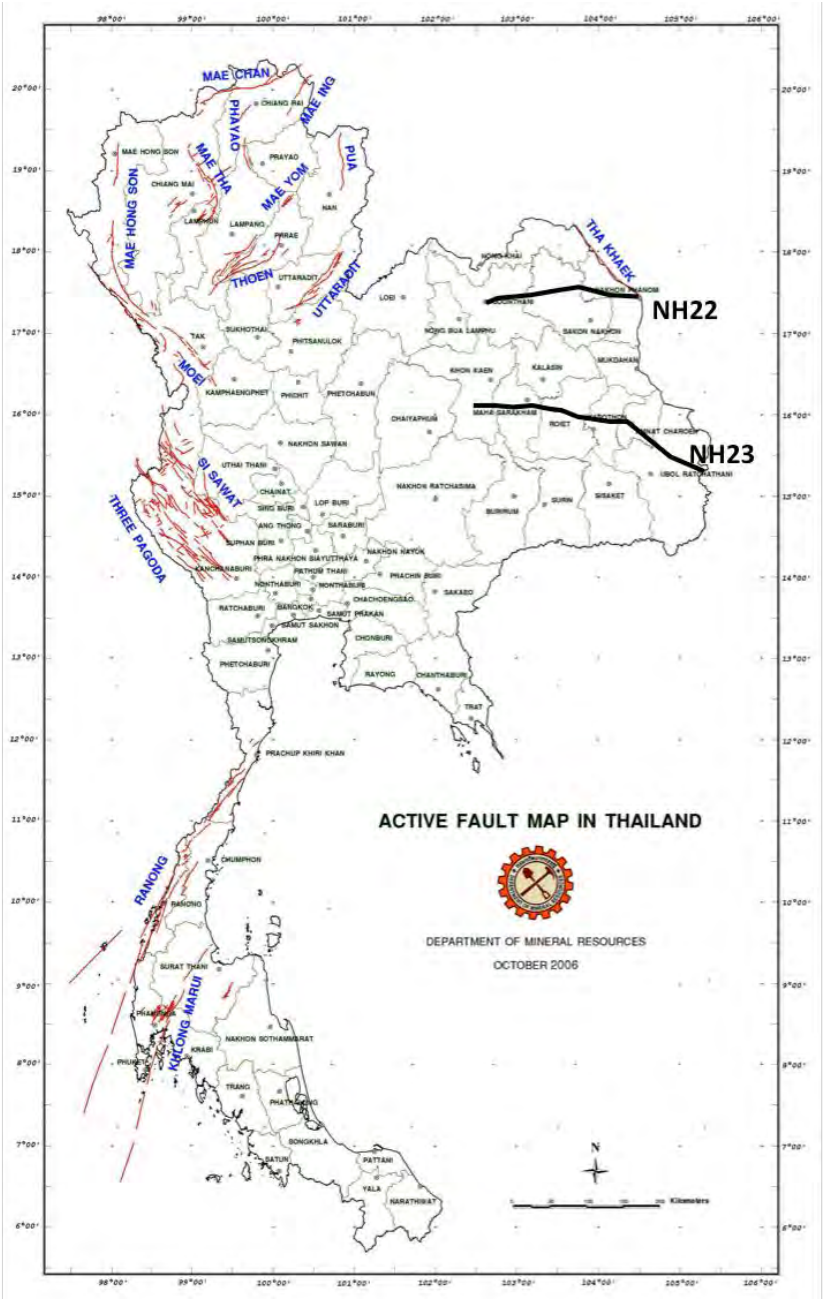

Figure 17: Active Fault in Thailand

Base Map Source: Department of Mineral Resources. 2006; http://dmr.go.th

F. Hydrology and Water Quality

146. **Surface Water.** There are no major surface waters that are traversed by NH22 except for roadside drainage canals, small creeks and irrigation channels. The vicinity is in a plateau and serves as the upstream areas of the Pong River, Chi River, Loei River and Pasak River, hence, most of the creeks are dry during the dry season. The project site is not identified as prone to flooding. However, stakeholders disclosed during the consultation meetings that clogged drainage canals occur because of disposal of wastes and backfilling by certain establishments to build access to private properties. Adequate drainage infrastructures and culverts of sufficient capacity are needed to avoid flooding during periods of heavy rainfall.

147. NH23 is located within the midstream section of the watershed of the Chi River. The Chi River is classified as Class 3 surface water with water quality suitable for agricultural use. The Regional Environment Office 12 through the Pollution Control Department has been monitoring the Chi River in five stations on a quarterly basis. The nearest monitoring stations to the proposed road section is at CI05 which is located at Ban Tha Khrai Klang sub-district, Selaphum District, Roi Et and CI104 located at Ban Bo Samran, Samran sub-district, Muang district, Yasothon.

148. The water quality monitoring results in Table 12 indicate that the water quality standards for BOD, NH_3-N, total coliform, and fecal coliform do not meet the water quality standard for Class 3 in all monitoring stations.

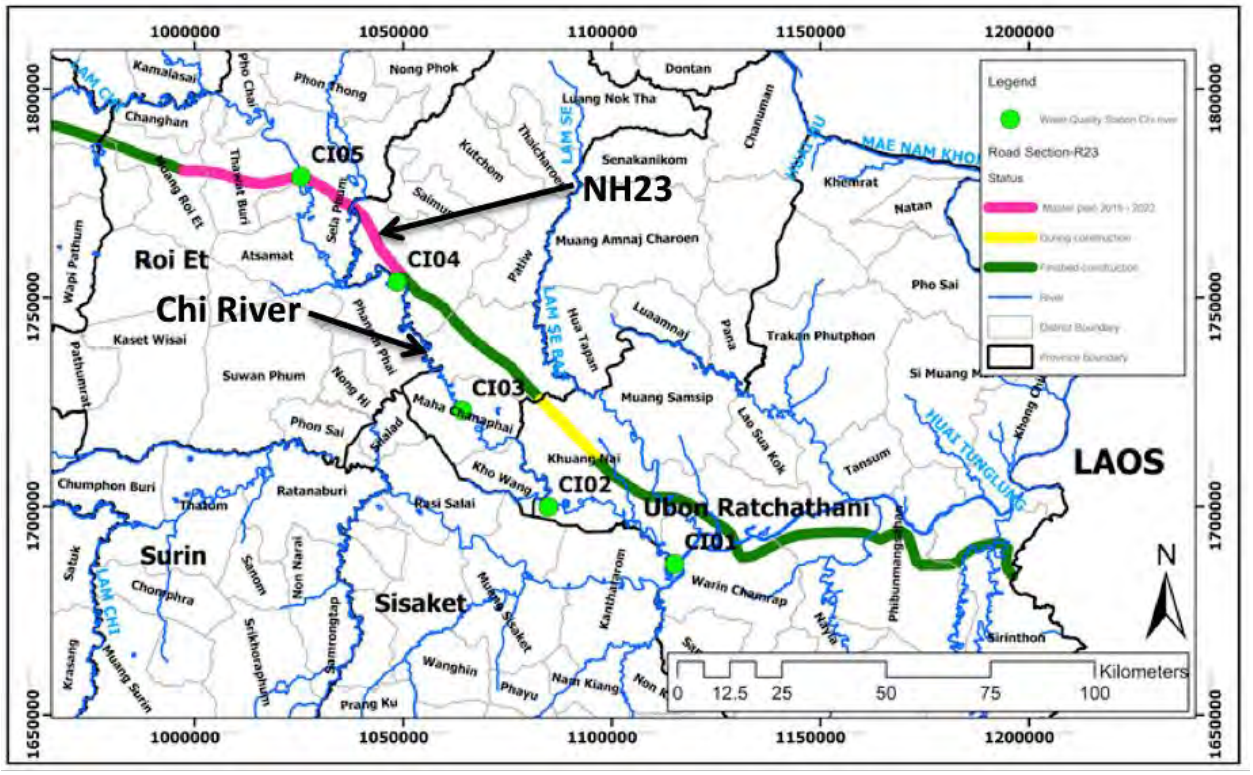

Figure 18: Water Quality Monitoring Stations at Chi River

Table 12: Water Quality of Chi River, 2016

Station	Description	Results
CL01	Ban Wang Yang, Bung Wai sub-district, Warinchamrab district, Ubon Ratchathani	NH3-N : 0.74 mg/l
CL02	Chi River Bridge, Ban Khok Thong, Khueang Nai District, Ubon Ratchathani	NH3-N : 0.78 mg/l
CL03	Chi River Bridge, Ban Fa Yat, Fa Yat sub-district, Maha Chana Chai District, Yasothon	BOD : 3.8 mg/l NH3-N : 0.93 mg/l
CL04	Chi River Bridge, Ban Bo Samran, Samran sub-district, Muang District, Yasothon	BOD : 2.7 mg/l Total Coliform : 40,548 MPN/100 ml Fecal Coliform : 40,318 MPN/100 ml NH3-N : 076 mg/l
CL05	Chi River Bridge, Ban Tha Khrai Klang sub-district, Selaphum District, Roi Et	BOD : 2.4 mg/l NH3-N : 0.86 mg/l

Notes:
(a) BOD water quality standard for Class 3 should not exceed 2 mg/l
(b) Total Coliform water quality standard for Class 3 should not exceed 20,000 MPN/100 ml
(c) Fecal Coliform water quality standard for Class 3 should not exceed 4,000 MPN/100 ml
(d) NH_3-N water quality standard for Class 2, 3, and 4 should not exceed 0.50 mg/l

Source: Regional Environmental Office 12 Ubon Ratchathani

149. **Groundwater.** The hydrogeological setting in northeastern Thailand can be described according to the rock types and water-bearing characteristics of the unconsolidated, upper Khorat, Middle Khorat, Lower Khorat, Rat Buri limestone and Metasediment aquifers. The unconsolidated aquifer is limited in extent and the thickness is not more than 50 meters. The alluvium of the rivers of Chi, Mun and their tributaries yield less than 15 m^3/hr. The Upper Khorat aquifer (cretaceous) consists of red, reddish brown and grayish brown shale, siltstone and sandstone of Sal and Khok Kruat Formations. At higher elevation, ground surface is flat and is underlain by soft shale and siltstone, with wells drilled to depth of about 30 – 40 meters which yields slightly brackish freshwater.[15]

G. Climate

150. The climate of Thailand is influenced by monsoon winds of seasonal character, i.e. southwest monsoon and northeast monsoon. The southwest monsoon begins in May and brings a stream of warm moist air from the Indian Ocean towards Thailand causing abundant rain over the country, particularly on the windward side of the mountains. Rainfall during this period in not only caused by the southwest monsoon but also by the Inter Tropical Convergence Zone (ITCZ) and tropical cyclones which produce large amounts of rainfall. The ITCZ starts in May to the southern part and moves northwards rapidly and lies across southern China around June to early July. During this period, there is dry spell over upper Thailand. The ITCZ then moves in a southerly direction to lie over the northern and northeastern regions of Thailand in August and later over the central and southern regions in September and October, respectively. The northeast monsoon, which starts in October, brings the cold and dry air from the anticyclone in China mainland over major parts of Thailand, especially in the northern and northeastern regions.[16]

[15] Source: Groundwater Resources of Northeastern Thailand. Somchai Wonsawat, et.al, Department of Mineral Resources. http://library.dmr.go.th
[16] Source: The Climate of Thailand. Thai Meteorological Department. http://tmd.go.th

151. **Temperature.** The northeastern region usually experiences a long period of warm weather because of its inland nature and tropical latitude zone. The hottest months occur in March to May with maximum temperatures usually reaching nearly 40°C or more except along coastal areas where sea breezes will moderate afternoon temperatures. The onset of the rainy season by mid-May also reduces the temperatures. The winter season, which is characterized by outbreaks of cold air from China, occasionally reduce temperatures to fairly low values in the northeastern region.

152. **Rainfall.** The onset of the southwest monsoon leads to intensive rainfall from mid-May until early October. Rainfall peak is in August or September. However, dry spells commonly occur for 1 to 2 weeks or more in June to early July due to the northward movement of the ITCZ to southern China. Table 13 presents the seasonal rainfall in the northeastern region.

Table 13: Seasonal rainfall (mm) in the Northeastern Region of Thailand

Season	Rainfall (mm)
Winter	76.3
Summer	224.4
Rainy	1,103.8
Annual Rainy Days	116

Note: Based on 1981-2010 period
Source: The Meteorological Department. http://www.tmd.go.th

153. **Tropical Cyclones.** Tropical cyclones affecting Thailand usually moves from the western North Pacific Ocean or the South China Sea. The country usually receives the effect of tropical depressions because of its location farther inland and some mountain ranges obstruct and decrease the wind speed. April is the first month when tropical cyclone move across Thailand. There is relatively higher frequency from May, particularly in September and October. The tropical cyclones usually pass through the northern and northeastern parts in early southwest monsoon season and move across the southern Thailand from October to December.

Table 14: Frequency of Tropical Cyclones Moving Through Thailand (1951 – 2015)

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
North	-	-	-	-	5	2	10	17	25	11	1	-	71
Northeast	-	-	-	-	1	6	4	18	33	25	4	-	91
Central	-	-	-	-	2	1	1	-	7	9	2	-	22
East	-	-	-	-	1	1	1	-	3	13	2	-	21
South	-	-	-	1	1	-	-	-	3	15	24	9	53

Source: The Meteorological Department. http://www.tmd.go.th

154. **Climate Change Vulnerability.** The northeastern region of Thailand is vulnerable to rising temperature as a result of climate change. The Thailand Meteorological Department reported in 2011 that average annual temperatures have significantly rises by about 0.95°C between 1955 and 2009 which is well above the average world temperature increase of 0.69°C. The annual highest, average and lowest temperatures have also been increasing by about 0.86°C, 0.95°C and 1.45°C, respectively over the past 55 years. The increase has been significant since 1994 based on data from the Climatological Center, 2010. The additional number of warm days and nights (>35°C and 25°C) in the northeast is projected to be about 20 days (Limsakul et.al., 2011). In terms of precipitation, the total amount of rainfall between 1955 and 2014 did not

change significantly (Limsakul and Singhruck, 2016) but there have been regional diverging trends in rainfall volume. The total rainfall in Central and East Thailand has a decreasing trend while increasing rainfall was observed in the northeast and Gulf region including the Bangkok metropolitan area.

155. Through the Southeast Asia START Regional Center (2006), a regional climate change scenario was developed in Thailand. The model predicted an increase in mean annual temperature by about 1 – 2°C in Southeast Asia as well as summer season defined as having mean daily temperatures above 33°C. The summer season is lengthened by 2 – 3 weeks while winter season is shorter with mean daily temperatures below 15°C. Localized model for Thailand and neighboring countries was developed by Chinvanno et.al. (2009) for future climate projection between 2010-2100.

156. Major climate models predicted that there will be temperature rise for the entire country, most particularly at the central plain and at the lower northeastern region. The lower northeastern region is where NH22 and NH23 are located. Projections for the increase in mean temperatures vary between 0.4°C and 4.0°C in the next 100 years (TRF, 2011) with an average of 29° – 33°C in the early 21st century to 33° – 35°C until the year 2100. The northeastern region is expected to have hot periods extended to 5 – 6 months, by the end of the century. In terms of rainfall intensity, the areas near the Mekong River are expected to experience increase in total annual precipitation.[17]

H. Air Quality

157. Ambient air quality, noise level and vibration sampling was conducted in four monitoring station at the project site on April 3 – 6, 2017. The ambient air sampling for criteria pollutants namely, Particulate Matter 10 (PM_{10}), Total Suspended Particulates (TSP), SO_2, and NO_2, was performed at the sampling stations. Figure 19 presents the location of the sampling stations for ambient air quality, noise and vibration.

[17] Naruchaikusol, S. (2016): Climate Change and its impact in Thailand. A short overview on actual and potential impacts of the changing climate in Southeast Asia, TransRe Fact Sheet No. 2, Department of Geography, University of Bonn, Bonn.

Figure 19: Baseline ambient air quality sampling at NH22 and NH23

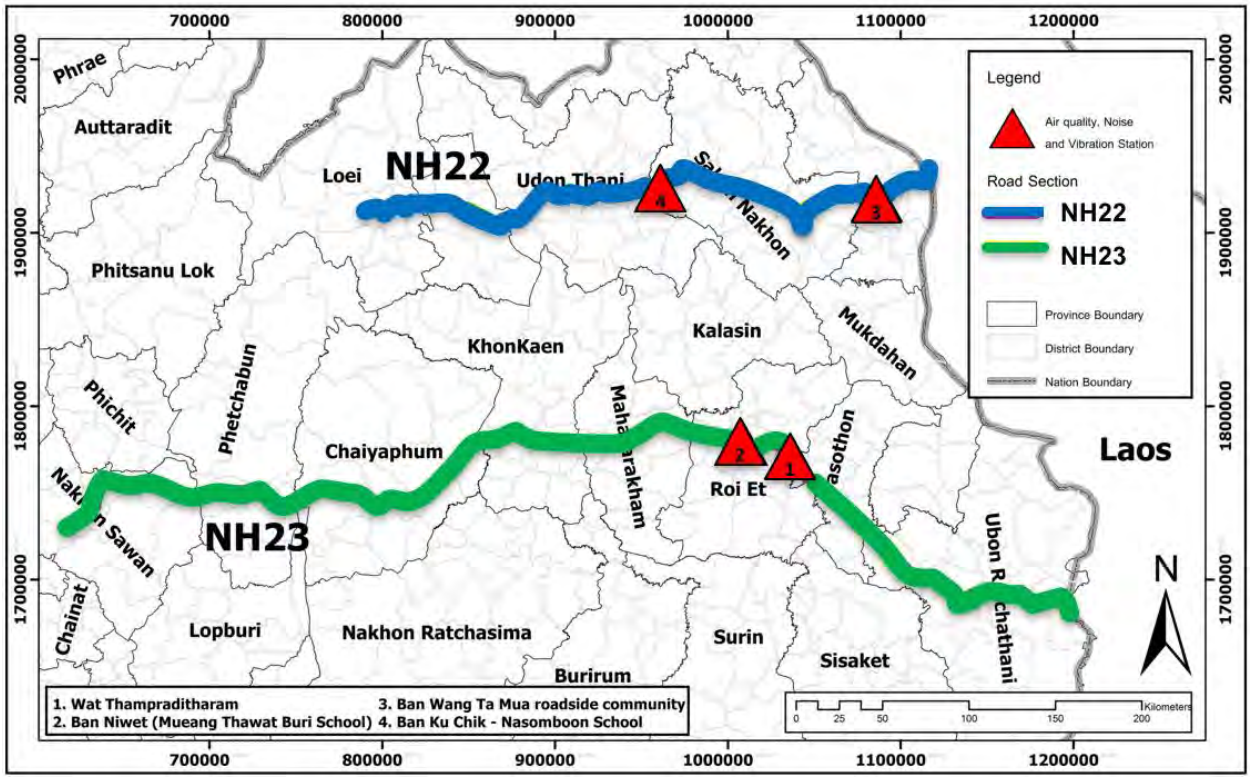

Figure 20: Location of Sampling Stations for Ambient Air Quality, Noise and Vibration

158. Ambient air quality sampling and analyses used the standard methods, as specified in the following table.

Table 15: Sampling Methodology

Parameter	Method of Measurement	Sampling Equipment
Particulate Matter 10 (PM_{10})	Gravimetric method	High Volume Sampler
Total suspended particulates (TSP)	Gravimetric method	High Volume Sampler
Sulfur dioxide (SO_2)	UV Fluorescence	SO_2 analyzer
Nitrogen dioxide (NO_2)	Chemiluminescense	NO/NO_2/NOx analyzer
Noise	Direct measurement	Integrated sound level meter
Vibration	Direct measurement	Vibration meter, resolution 0.127 mm/s

159. Appendix 4 presents the ambient air, noise and vibration sampling results.

160. The results of analysis were compared with the Ambient Air Quality Standards based on Notification of NEB No. 10 (1995). The results indicate that the PM_{10}, TSP, SO_2, and NO_2 concentrations in all sampling stations were within the applicable standards.

Table 16: Measured Ambient Air Concentration for 24-Hour Monitoring (ppm)

Location	Date / Time of Sampling	PM_{10}	TSP	SO_2	NO_2
Ban Kuchik-Nasomboon School, Sakon Nakhon	April 3 - 4, 2017 10:00 – 10:00	0.041	0.069	0.0014	0.01159
Ban Wang Ta Mua Roadside Community (Wang Ta Mua Temple), Nakhon Phanom	April 3 - 4, 2017 14:00 – 14:00	0.024	0.034	0.0024	0.00220
Ban Niwet (Mueng Thawat Buri School), Roi Et	April 5 - 6, 2017 09:00 – 09:00	0.057	0.082	0.0012	0.00702
Thampraditharam Temple, Ban Non Yang, Roi Et	April 5 - 6, 2017 11:00 – 11:00	0.063	0.085	0.0026	0.00374
Standard		**<0.12**	**<0.33**	**<0.12**	**<0.17**

Source: Results of Environmental Monitoring conducted by UAE Consultant Company, April 2017

161. Sources of air emissions at the project site are due mainly from vehicular exhausts and the occasional burning of domestic and agricultural wastes by the community.

162. The Regional Environmental Office 9 monitors PM_{10} in urban areas in six provinces to determine health effects to people. There is no ambient air quality monitoring along NH22. The nearest monitoring stations are located at Sakon Nakhon Provincial Office Highway District 1, in Nakon Phanom Provincial Office of Natural Resources and Environment and at the official residence in Nakon Phanom. Monitoring results in 2015 are shown in Table 17.

Table 17: Ambient Air Quality Monitoring by Regional Environmental Office 9

Sampling Station	Location	Sampling Period	PM_{10} Concentration (ug/m^3)	Pass / Fail
Sakon Nakhon Provincial Office Highway 1	Muang district, Sakon Nakhon	February 23 – 26, 2015	50 - 86	Pass
Nakon Phanom Provincial Office of Natural Resources and Environment	Muang District, Nakon Phanom	March 9 – 12, 2015	38 - 87	Pass
Ban Phrae residential area	Muang District, Nakon Phanom	April 17 – 20, 2015	119 - 149	Fail
PM_{10} Standard			120	

163. Measurement of PM_{10} was conducted for 24 hours for 3 days. In Nakon Phanom province, the monitoring results indicated that PM_{10} exceeded the standard value of 120 ug/m^3 at the official residence. The monitoring station is located along Soontornvijit Road, Muang District, Nakon Phanom province which is an area characterized as densely populated and with traffic congestion. Sources of PM_{10} are the emissions from vehicles and roadside dusts.

164. Secondary data on ambient air quality was gathered from the Regional Environmental Office 12 in Ubon Ratchathani. There are no monitoring stations along NH23. The nearest monitoring stations are located at Yasothon Municipal Office and Roi Et Provincial Office of Natural Resources and Environment. Monitoring results are available for 2013-2015 for PM_{10} as shown in Table 18.

Table 18: Ambient Air Quality Monitoring by Regional Environment Office 12

Sampling Station	Type of Community	PM10 (ug/m^3)				PM10 Standard ($\mu g/m^3$)	Pass / Fail
		2013	2014	2015	2016		
Yasothon Municipal Office	Urban	27.43	23.33	89.99	74.00	≤120	Pass
Roi Et Provincial Office of Natural Resources and Environment, Muang	Urban	48.71	24.33	45.72	90.00		Pass

Source: Regional Environmental Office 12 Ubon Ratchathani

165. According to the National Environmental Board's Announcement No. 10 1995, the average PM_{10} over 24-hour period should not exceed 120 ug/m^3. The monitoring results from 2013 – 2015 indicate that the average PM_{10} has not exceeded the standards. However, the trend indicates that PM_{10} is increasing over the years.

I. Greenhouse Gas Emissions

166. Thailand continues to experience increased vulnerability to climate change and climate variability and extreme events. The Government of Thailand reported to the United Nations Framework Convention on Climate Change (UNFCCC) the 2000 – 2004 inventory of greenhouse

gas (GHG) emission. The inventory reported a total of 210.23 million tons of CO_2 were emitted while 52.37 million tons of CO_2 were absorbed. The country's net CO_2 emission in 2000 was 157.86 million tons, which is lower than the 1994 reported values. Of the total CO_2 emission in 2000, power generation was the largest contributor of GHG with more than 90% of the net CO_2 emission. Other sources of GHG are agriculture and land use change and forestry. Under the energy sector, power generator was the largest emitter of CO_2 (64.2 million tons), followed by transportation at 44.4 million tons, and industry at 30.3 million tons. The country's proposed GHG mitigation include the introduction of efficient technologies and systems for traffic and mass transport.[18]

J. Noise

167. Noise sampling was conducted using an integrated sound level meter manufactured by Svantek Model SV35 / 44792. Noise measurements showed low ambient levels in the project area and surrounding community. The primary noise sources are community noise and movement of vehicles on the existing highways. Results of noise level monitoring are summarized in Table 19.

168. The noise sampling results in all monitoring stations when compared with the EHS noise standards for one hour L_{Aeq} of 45 dBA nighttime and 55 dB(A) daytime[19] exceeded the daytime and nighttime guideline values at Ban KuChik Nasomboon School in Sakon Nakon at 93.3% (daytime) and 100% (nighttime) of the sampling period, respectively. The highest daytime $L_{Aeq1\text{-}hr}$ (65 dBA) occurred at 17:00-18:00 while the peak nighttime $L_{Aeq1\text{-}hr}$ (58.1 dBA) was at 05:00-06:00.

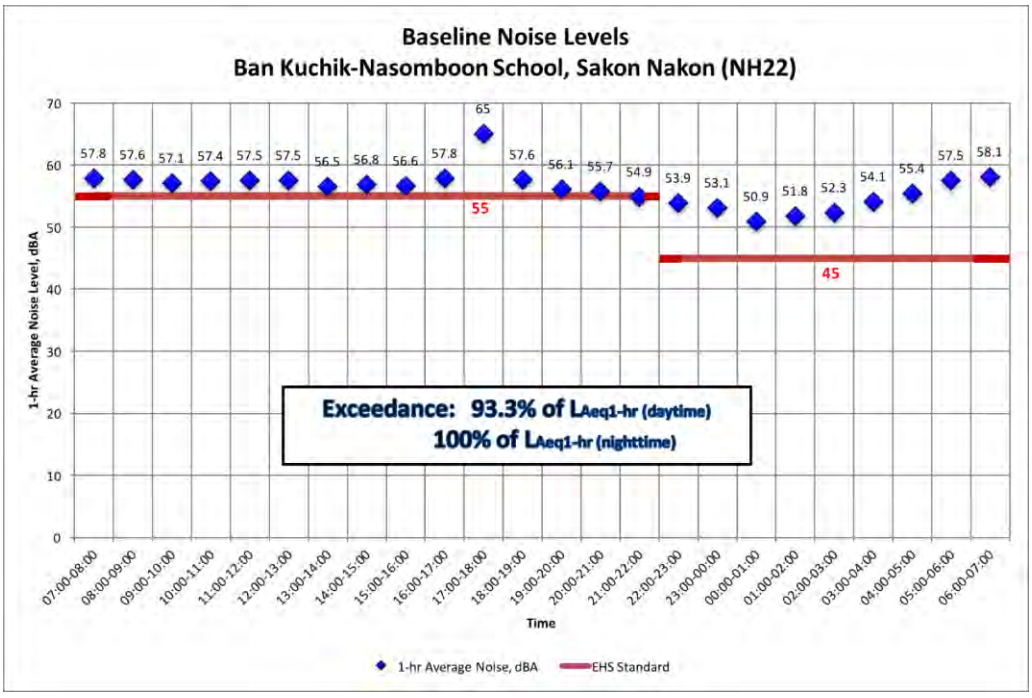

Figure 21: Comparison of Baseline Noise Levels at Ban Kuchik-Nasomboon School, Sakon Nakhon (NH22) with EHS Standards

[18] Thailand's Second National Communication under the United Nations Framework Convention on Climate Change. Office of Natural Resources and Environment. 2011

[19] Daytime refers to the period from 07:00-22:00 while nighttime refers to the period from 22:00-07:00.

169. At Ban Wang Ta Mua in Nakhon Phanom, the daytime hourly noise readings exceeded the daytime EHS standard only once at 07:00 – 08:00, representing 6.7% of the hourly daytime readings while the nighttime $L_{Aeq\ 1\text{-}hr}$ was exceeded 33.3% of the hourly nighttime noise levels. In general, the vicinity of NH22 road section in Nakon Phanom is characterized as agricultural with many open fields, hence, noise sampling results are not influenced by community activities.

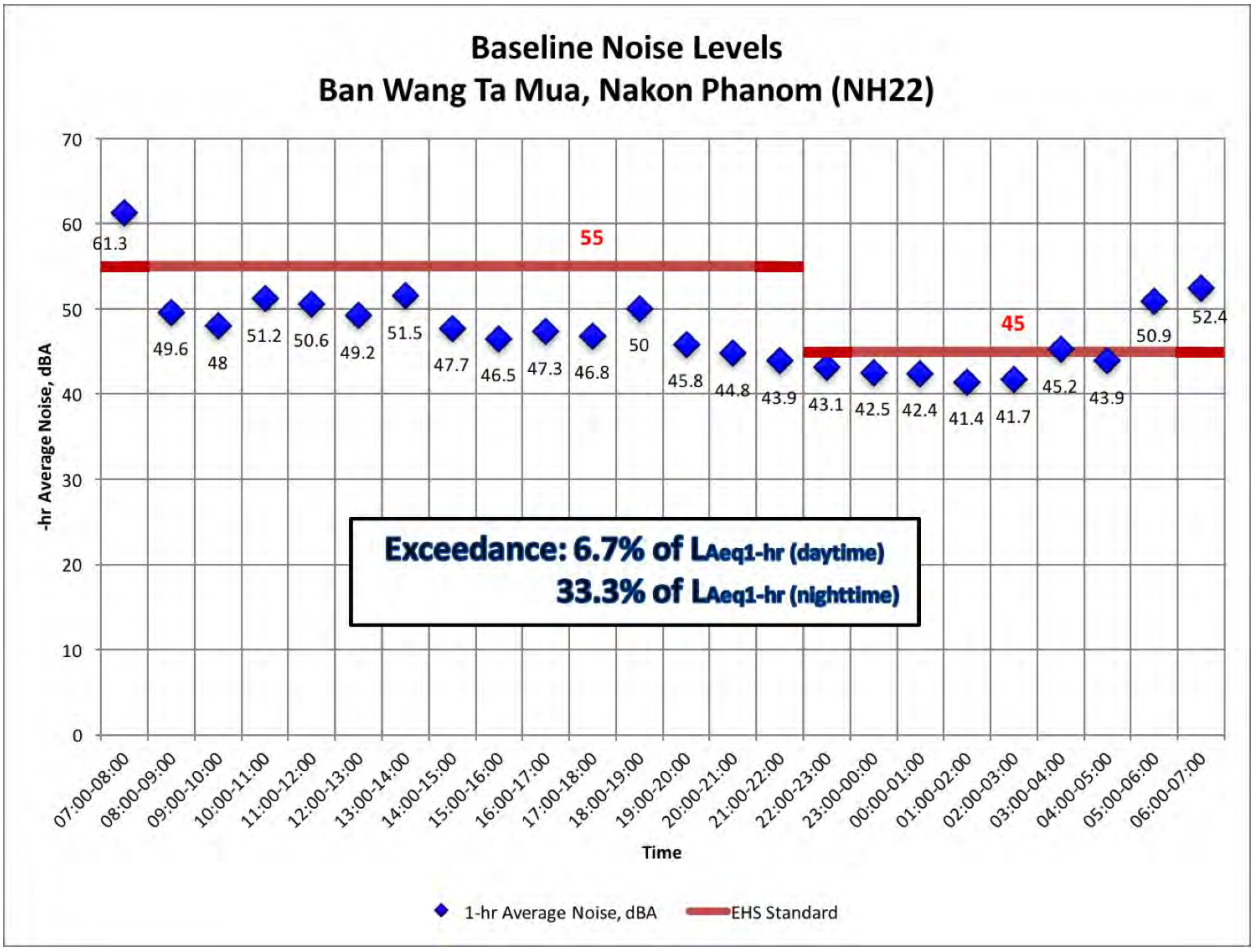

Figure 22: Comparison of Baseline Noise Levels at Ban Wang Ta Mua, Nakon Phanom (NH22) with EHS Standard

170. In Ban Niwet (Muang Thawat Buri School), Roi Et Province, the $L_{Aeq1\text{-}hr}$ was exceeded 26.7% of the daytime noise measurements and 100% of the nighttime noise measurements. The noise sampling results may have been affected by community and residential activities in the surrounding area during daytime while nighttime noise is primarily attributed to the movement of vehicles along NH22.

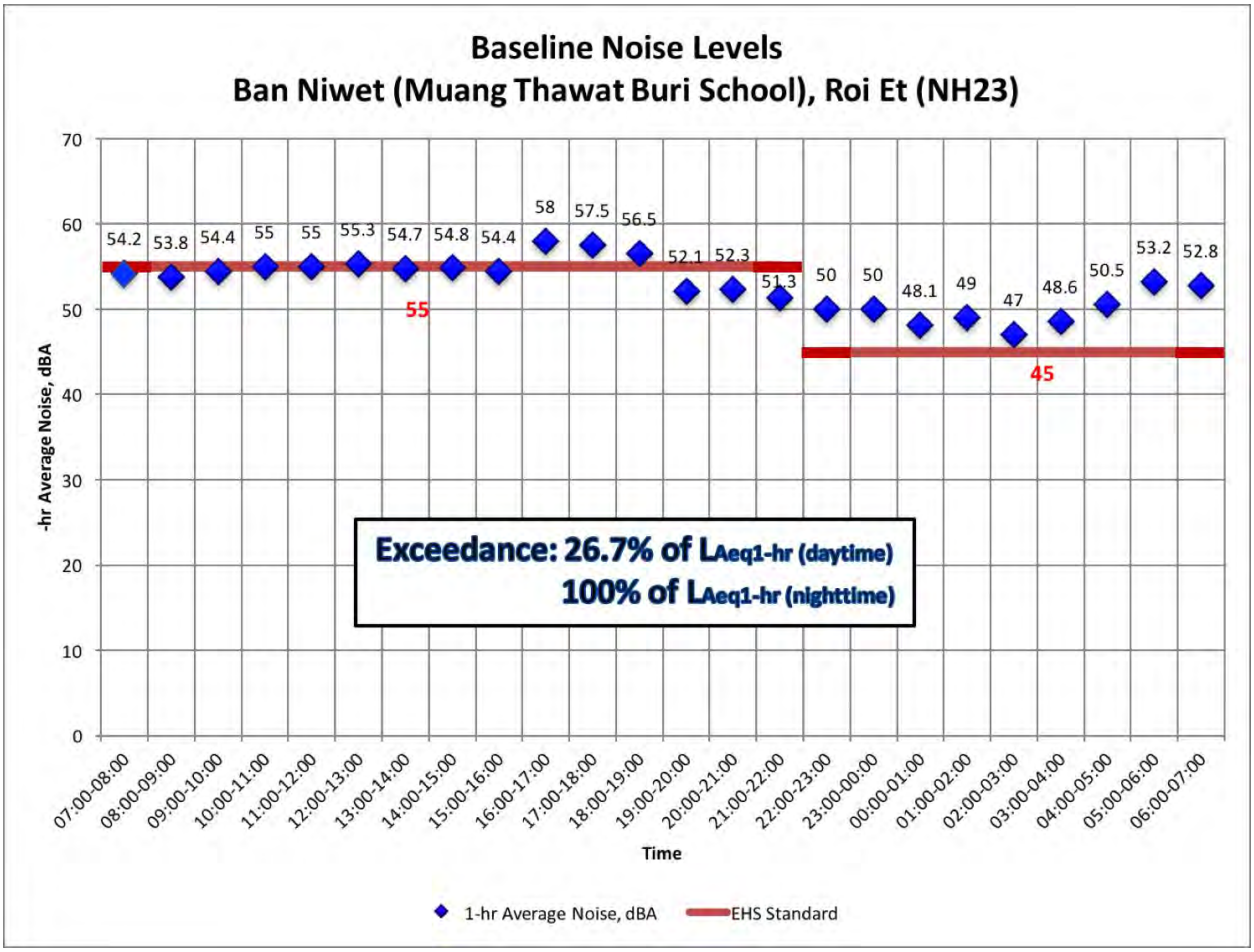

Figure 23: Comparison of Baseline Noise Levels at Ban Niwet, Roi Et (NH23) with EHS Standard

171. In Tham Pradittharam Temple in Ban Nonyang, the daytime noise measurement was not exceeded during daytime while the nighttime $L_{Aeq1\text{-}hr}$ was exceeded 100% of the sampling time. The exceedances in the nighttime $L_{Aeq1\text{-}hr}$ at NH23 is primarily due to large cargo vehicle movement.

172. In addition, noise is primarily attributed to the community noise and movement of vehicles along the existing roads along sections of NH22 and NH23 that have poor pavement. At night, the vehicles tend to move faster than at daytime, thus, resulting to higher noise levels.

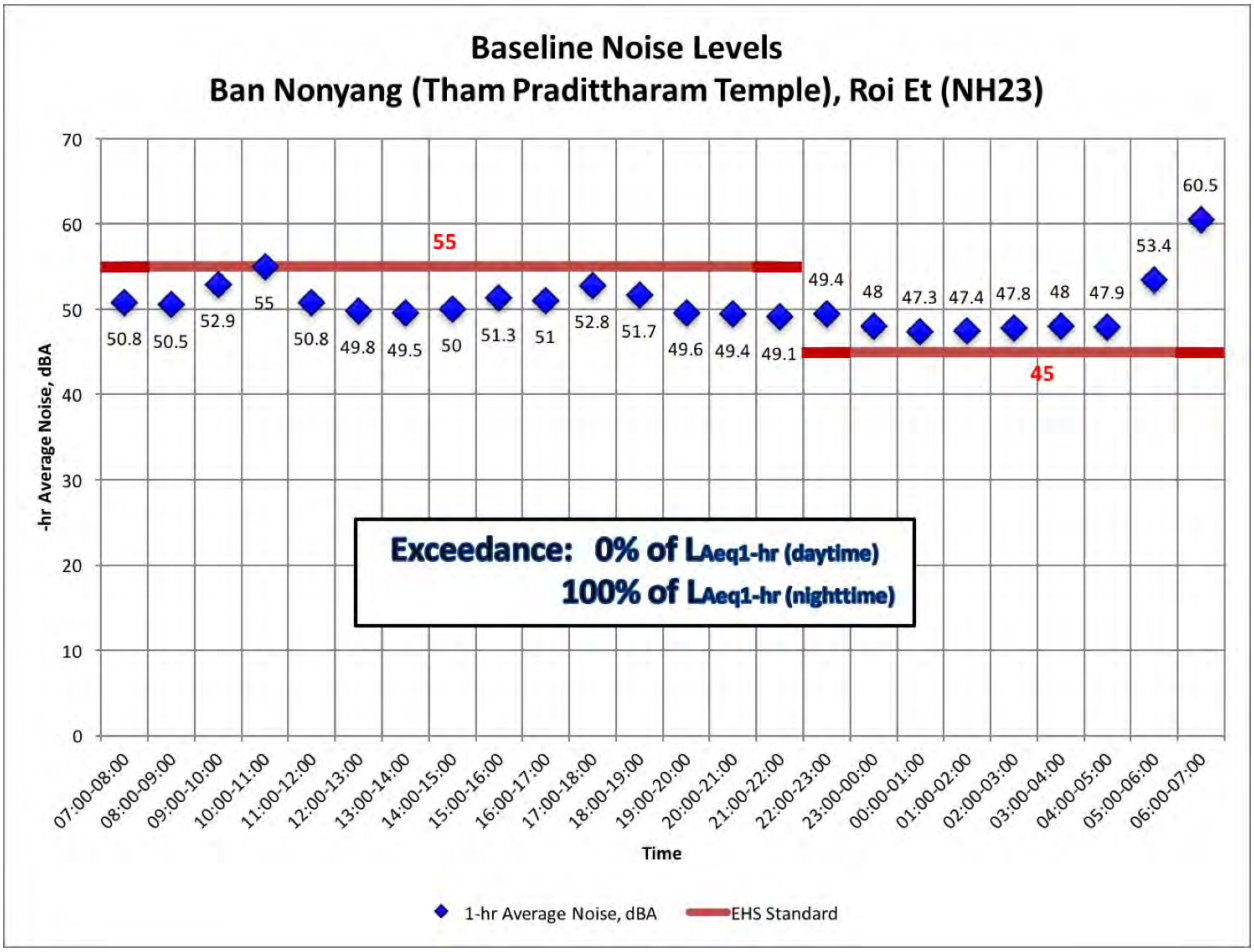

Figure 24: Comparison of Baseline Noise Levels at Ban Nonyang, Roi Et (NH23) with EHS Standard

173. The noise sampling results in all monitoring stations were compared with the WB/IFC Environment Health and Safety guidelines for one hour LAeq of 45dBA nighttime and 55dB(A) daytime. The sampling results indicate that the hourly daytime and nighttime noise levels exceeded the daytime and nighttime guideline values at Ban KuChik Nasomboon School in Sakon Nakon at 90% and 100% of the sampling period, respectively. The highest daytime LAeq1-hr (65 dBA) occurred at 17:00-18:00 while the peak nighttime LAeq1-hr (58.1 dBA) was at 05:00-06:00. Note that the noise sampling station was positioned at the open field of the school which directly exposes the station to road traffic noise. Noise levels are expected to be less inside the school buildings/classrooms which are located about 50 meters further form the school. At Ban Wang Ta Mua in Nakhon Phanom, the daytime hourly noise readings exceeded the daytime standards only once at 07:00 – 08:00 while the nighttime LAeq 1-hr was exceeded 22% of the sampling time.

Table 19: Noise Level Monitoring Results, dB(A)

Location	Date / Time of Sampling	$L_{Aeq\ 24\ hr}$	L_{Amax}	L_{Adn}	$L_{Aeq1\text{-}hr}$ % Exceedance with EHS Standard	
					Daytime	Nighttime
Ban Kuchik-Nasomboon School, Sakon Nakhon	April 3 – 4, 2017	57.3	85.8	62.9	93.3%	100%

Location	Date / Time of Sampling	$L_{Aeq\ 24\ hr}$	L_{Amax}	L_{Adn}	$L_{Aeq1\text{-}hr}$ % Exceedance with EHS Standard	
					Daytime	Nighttime
	10:00 – 10:00		(17:00-18:00)			
Ban Wang Ta Mua Roadside Community (Wang Ta Mua Temple), Nakhon Phanom	April 3 – 4, 2017 14:00 – 14:00	50.7	76.2 (07:00-08:00)	59.9	6.7%	33.3%
Ban Niwet (Mueng Thawat Buri School), Roi Et	April 5 – 6, 2017 09:00 – 09:00	53.8	80.0 (09:00-10:00)	58.6	26.7%	100%
Thampraditharam Temple, Ban Non Yang, Roi Et	April 5 – 6, 2017 11:00 – 11:00	52.0	82.3 (06:00-07:00)	60.0	0%	100%
Thai Standard		**<70 dB(A)**	**<115 dB(A)**			
EHS Standards					**55dB(A)**	**45dB(A)**

174. In Ban Niwet (Muang Thawat Buri School), Roi Et Province, the LAeq1-hr was exceeded 40% of the daytime noise measurements and 100% of the nighttime noise measurements. Similar to the station in Ban KuChik, the measurements were made at the open area inside the school premises to measure road traffic and therefore noise levels are expected to be less inside the school classrooms.

175. In Tham Pradittharam Temple in Ban Nonyang, the daytime noise measurement was exceeded only once at 10:00-11:00 and the nigthttime LAeq1-hr was exceeded 100% of the sampling time. The exceedances in the nighttime LAeq1-hr at NH23 is primarily due to more large cargo vehicle movement that occurs on the road during nighttime. In addition, noise is primarily attributed to the community noise and movement of vehicles along the existing roads along sections of NH22 and NH23 that have poor pavement. At night, the vehicles tend to move faster than at daytime, thus, resulting to higher noise levels.

176. When the baseline noise sampling results of the 24-hour mean noise level were compared with the national noise standard (<70 dB(A)) as stipulated in National Environment Board No. 15 (B.E. 2540), the Leq24-hr were all below the national standards and that there was no noise level reading greater than 70.0 dB(A) in all monitoring stations. Likewise, the Lmax for all stations were well below national ambient noise standard (<115 dB(A)).

Figure 25: Baseline noise measurement at NH22 and NH23

K. Vibration

177. Vibration was monitored at the same air quality monitoring stations. The vibration meter was placed in buildings of temples, statues and other old structures that may be affected by the road project. Vibration measurements were made of ground borne acceleration at the four sampling stations near NH22 and NH23. All the measurements were way below the perceptible limit of the vibration meter. Results of vibration tests are shown in Table 20.

178. Measured vibration level is compared with vibration standard level threshold for human reception (Reiher & Meister). It was concluded that all of measured vibration still complied with standard threshold level 3, which is sensible by human receptor (<0.15 - 0.30 mm/sec), and has no significant impact in comparison with NEB No. 37 standard for old building receptor (<3.00 mm/sec). The existing vibration levels do not cause human discomfort or damage to buildings.

Table 20: Results of Vibration Monitoring

Location	Date / Time of Sampling	Velocity (mm/s)		
		X-Axis	Y-Axis	Z-Axis
Ban Kuchik-Nasomboon School, Sakon Nakhon	April 3 – 4, 2017 10:00 – 10:00	<0.127	<0.127	<0.127
Ban Wang Ta Mua Roadside Community (Wang Ta Mua Temple), Nakhon Phanom	April 3 – 4, 2017 14:00 – 14:00	<0.127	<0.127	<0.127
Ban Niwet (Mueng Thawat Buri School), Roi Et	April 5 – 6, 2017 09:00 – 09:00	<0.127	<0.127	<0.127
Thampraditharam Temple, Ban Non Yang, Roi Et	April 5 – 6, 2017 11:00 – 11:00	<0.127	<0.127	<0.127
Standard		**<3 mm/s (old buildings)[a]**		

Notes:
(a) Based on Notification of the NEB, No. 37, B.E. 2553 (2010)

Figure 26: Baseline vibration measurement at NH22 and NH23

L. Biological Resources

1. Terrestrial Resources

179. **Flora.** The project will not pass through or near any forest conservation, protected area or ecologically sensitive areas. The ROW has been established when the existing road was constructed. Majority of the ROW will be through agricultural areas and community areas. The nearest protected area is the Phu Phalek Protected Area which is located about 30 km away. However, there are trees within the established ROW which may be affected by the road widening project. Majority of the trees were planted by DOH on the existing roadside as part of landscaping and ROW border to discourage encroachment.

180. The survey of trees within NH22 and NH23 recorded a total of 1,879 trees. Key tree species included *Tectona gradis L.* (teak), *Pterocarpus macrocarpus Kurz.* (padauk), *Gmelina arborea*, *Lagerstroemia duperreana Pierre ex Gagnep* (tagab prukbang), *Pterocarpus indicus* (*Willd.*), *Azadirachta indica A. Juss Var. Siamensis Valeton* (Neem), and *Dipterocarpus Roxb. Ex. G. Don* (Yang Na). The most number of species within NH22 are *Tectona gradis L.* (teak) and *Pterocarpus macrocarpus* (padauk) while the most frequently found within NH23 are *Azadirachta Indica A. Juss. Var. Siamensis Valeton* (Neem) and *Dipterocarpus alatus Roxb. Ex. G. Don* (Yang Na).

181. At NH22, the inventory of trees within the 60-meter ROW showed a total of 1,420 affected trees, majority of which are teak, padauk and Gmelina trees. About 779 trees are found on the left side of the road while 641 trees are on the right side.

Table 21: Tree Species Within NH22

Type of Tree Species	Common Name	Left (LT)		Right (RT)	
		Number of Trees (LT)	Circumference, inches	Number of Trees (RT)	Circumference, inches
Dipterocarpus intricatus	Yang-krat	2	20 - 36	2	13 - 18
Pterocarpus macrocarpus Kurz.	Padauk	208	4 – 44	0	-

Type of Tree Species	Common Name	Left (LT)		Right (RT)	
		Number of Trees (LT)	Circumference, inches	Number of Trees (RT)	Circumference, inches
Melaleuca cajuputi	Cajuput	1	10	0	-
Crytolepis buchanani Roem	Ganglong	2	11 – 16	0	-
Anisoptera costata Korth	Mersawa Kesat, Pengiran Kesat	10	6 – 19	0	-
Erythrophlejum succirubrum Gagnep	Chad	10	7 – 21	0	-
Tectona grandis L.	Teak	387	2 – 25	561	3 - 20
Barringtonia fusifomis King.	-	4	6 – 15	0	-
Gmelina arborea	Gmelina	67	8 – 24	0	-
Cissampelos pareira	Velvetleaf	7	6 – 19	0	-
Xylia xylocarpa	-	4	9 – 14	14	5 – 18
Lagerstroemia duperreana Peirre ex Gagnep	Tagab prukbang	45	8 – 19	1	11
Sindora siamensis Teijsm.	-	5	6 – 23	0	-
Irvingia malayana		2	13 - 38	2	30 - 71
Eclipta prostrate (L.) L.	False daisy Karisalaankanni	11	8 – 25	0	
Dipterocarpus alatus Roxb. Ex G. Don	Yang Na	1	14	0	-
Dalbergia cochichinensis	Siamese Rosewood	3	8 – 20	0	-
Peltophorum dasyrachis (Mig.) Kurz	Copper Pod, Yellow Flame	1	13	0	-
Pterocarpus indicus Willd.	Burmese Rosewood	0	-	21	4 - 20
Shorea siamensis Miq.	Light Red Meranti (Red Lauan)	0	-	3	4 – 20
Cryptolepsis dubia (Burm. F.)	-	0		9	8 – 15
Cratoxylum formosum	-	0	-	1	13
Pterospermum littorale Craib var. litorale	-	0	-	1	13
Erythopheleum succirubrum Gagnep.	-	0	-	2	13 - 15
Trichosanthes cucumerina Linn.	Snake gourd	0	-	13	8 – 36
Shorea obtusa Wall. ex blume	-	0		11	8 - 43
TOTAL		**779**		**641**	

182. Within NH23 road alignment in Roi Et, there are 175 affected trees that primarily consists of Neem and Yang Na species. There are 284 affected trees in Yasothon which mostly consist of tall Yang Na trees. Big Yang trees can be found in Yasothon district such as near the Non Yang school, Bodindecha military camp, and the community forest temple in Ban Chuek.

Table 22: Tree Species Within NH23

Tree Species	Common Name	Number of Trees	Circumference, meter
Dipterocarpus alatus Roxb. Ex G.Don	Yang Na	273	0.3 – 3.30
Erythrophleum succirubrum Gagnep.	Chad	2	1.60 – 2.30
Anisoptera costata Korth.	Mersawa Kesat, Pengiran Kesat	28	0.7 – 4.0
Peltophorum dasyrrhachis (Miq.) Kurz	Copper Pod, Yellow Flame	22	0.5 – 2.0
Albizia procera Benth.	White siris, suan, thingthon	14	1.9 – 3.0
Dipterocarpus intricatus	Yang-krat	16	0.3 - 2.2
Parinari anamense Hance	-	5	2.0 – 3.0
Pterocarpus indicus Willd	Burmese Rosewood	20	0.3 – 1.9
Azadirachta indica A. Juss. Var. Siamensis Valeton	Neem	42	0.8 – 2.6
Dalbergia cochinchinensis	Siamese Rosewood	11	0.6 – 1.8
Tectona grandis L.F.	Teak	11	1.0 – 2.1
Dipterocarpus tuberculatus Roxb.	-	2	2.5
Lagerstroemia floribunda Jack	Tagab prukbang	3	1.3 – 1.7
Irvingia malayana Oliv.ex. A.W.Benn	Barking deer's mango, Wild Almond	1	0.4
Shorea roxburghii G.Don	Shorea, White meranti	8	0.4-1.2
Xylia xylocarpa	Iron wood, Irul, Jamba, Pyinkado	1	1.0
TOTAL		**459**	

183. **Fauna.** There are no known or reported endangered or threatened species in the area of NH22 and NH23 based on interviews with communities in the area. The ROW is a disturbed habitat for wildlife species. Common animals that can be found in the vicinity are cows, buffalos, chickens, and domesticated animals such as dogs and cats. The project location is one of the important livestock production areas of the country. Buffalo and cattle provide the main sources of power for paddy rice production under prevailing rainfed conditions. In addition, these animals serve as long-term saving for special occasions such as wedding ceremonies, a son entering monkhood, severe drought or flood. Almost 70% of buffalo and more than 35% of cattle in Thailand are found in this region.[20] Buffalo and cattle are grazed on public areas such as village communal land, roadsides, or on private land under fallow and on upper paddy fields where crops are not planted due to insufficient water.

[20] Source: Food and Agriculture Organization. Crop-Livestock Integration in Northeast Thailand: Problems and Prospects. Chalermkiat Saisoong. http://fao.org

2. Aquatic Resources

184. NH22 do not have abundant aquatic biodiversity since the road primarily passes through agricultural fields and community areas. Considered as waterways along NH22 at the two road sections are small canals and irrigation channels. At NH23, the road is within the Chi River basin. Types of fish that can be found are native riverine catfish (*Pangasius hypophthalmus*).[21] This type of fish is also being farmed on a small scale in pens and ponds.

M. Social and Cultural Resources

1. Population

185. **National Highway 22.** The province of Sakon Nakhon covers an area of 9,605.764 sq.km. It has a population of 571,510 people and household population of 352,795 as of 2015. The population density of the province is 118.85 capita per sq.km. Nakon Phanom has a population of 714,496 people and a household population of 212,947 as of 2015. The population density in Nakon Phanom is higher than in Sakon Nakhon with 129.61 capita per sq.km. [22]

186. **National Highway 23.** The province of Roi Et has the second largest population in Ubon Ratchathani region with 1,308,166 people and the highest population density of 157.62 persons per sq.km. in 2016. This is followed by Yasothon Province with 129.80 persons per square kilometer and a population of 540,182 people.[23]

2. Economy and Livelihood

187. The World Bank and the Northeastern Region Economic and Social Development Office (NEESO) prepared a study in 2005 to assess the economy of the region and the needs of the communities. The report concluded that the northeast is one of the fastest growing economies in the world and that average per capita growth rate was at 3.3 percent since 1970. Industry increased from the early 1990s onwards and agriculture contributes much to the gross domestic product (GDP). The service sector recorded the largest gains and provides over three fifths of the GDP.

3. Household Income

188. Due to the growing economy of northeastern Thailand, household living standards improved dramatically. Poverty headcount decreased from 48 percent in 1988 to 17 percent in 2002, notwithstanding the increase in population.[24] The rising living standards are visible in higher income and consumption.

189. **Sakon Phanom.** Based on the 2012 census, there are 182,666 households that reported an average annual income of 52,251 Baht per capita. There were 792 households with incomes lower than 30,000 Baht per capita per year. Majority of the sources of income are from agriculture, educational service, industry, trading, and other activities. Sakon Nakhon is famous for the Phone Yang Kham beef and local dyed cotton products. Cattle raising is a major source of income in the province.

[21] Source: Asian Development Bank. Case Study 7: Overview of Small-Scale Freshwater Aquaculture in Thailand.
[22] http://stat.dopa.go.th/stat/statnew/upstat_m.php
[23] Department of Provincial Administration. Ministry of Interior. http://stat.bora.dopa.go.th.th/stat/y_stat.htm
[24] Thailand Northeast Economic Development Report. November 2005. World Bank.

190. **Nakon Phanom.** The 2010 census reported that of the 115,427 households in Nakhon Phanom, average annual income was 41,377.42 Baht per capita, with only 3 households having income lower than 23,000 Baht per capita per year. Most of the income are from rice cultivation, wages, government service and trading. There are 596,432 people in the working age group, most are working in the agricultural sector.

191. **Roi Et.** According to the 2016 data, average income per capita per year in the province is 72,773 Baht. There were 780 households or 0.3% with incomes lower than 30,000 Baht per capita per year. There are 572,103 people in the working age group. Most of them are involved in the agriculture sector.

192. **Yasothon.** According to the 2015 census, the survey of 127,173 households with 416,923 population, reported that average income per capita per year was 65,358 Baht. There were 218 households with income lower than 30,000 Baht per capita per year. The working age group in the province was 292,957, where 60% are working the agriculture sector and rest are involved in industrial, commercial, transport, and service sectors.

4. Health

193. Information taken from the 2015 Survey on Health and Welfare of the National Statistical Office show that the leading cause of illness in the northeastern region of Thailand is cold/cough/runny nose, followed by chronic disease, disease of the musculoskeletal system, fever, stomachache/indigestion/gastritis, and diarrhea/dysentery. In terms of the chronic diseases, the leading chronic diseases in the northeastern region are cardiovascular diseases, diabetes/endocrine system and metabolic disorders, musculoskeletal disorders, and chronic respiratory diseases.

Table 23: Leading Causes of Illnesses and Chronic Diseases in Northeastern Region, 2015

Illness	Number of Population	Chronic Disease	Number of Population
Colds/cough/runny nose	913,050	Cancers	42,142
Fever, cough and wheezing/pneumonia	116,066	Diabetes/endocrine system and metabolic disorders	987,451
Fever	355,827	Mental disorders	85,928
Diarrhea/dysentery	186,280	Neurological disorders	50,601
Coccidiosis/mucus, blood transfusion and fever	21,944	Sensory disorders	76,311
Stomachache/flatulence/gastritis	287,755	Cardiovascular diseases	1,546,343
Disease of the musculoskeletal system	450,960	Chronic respiratory diseases	310,998
Disease of the nervous system	240,837	Digestive disorders	195,039
Disease of the skin	62,922	Genitourinary diseases	97,632
Ear, throat, nose, eye disease	36,248	Musculoskeletal disorders	336,338
Oral cavity	28,162	Infections	17,449
Chronic disease	567,343	Congenital anomalies	65,508

Illness	Number of Population	Chronic Disease	Number of Population
Others	106,694	Others	211,262
Unknown	1,219	Unknown	2,249

Source: 2015 Survey on Health and Welfare. National Statistical Office. Ministry of Information and Communication Technology

5. Water Supply

194. Water supply in the northeastern region of Thailand is from tap water, ground water, well, and water from river/canal, and rain water. For drinking water, the population in the northeastern region primarily buy bottled water or from water vending machines. This is followed by rainwater as a source of drinking water. Other drinking water sources are purified tap water which is boiled/filtered, well, and tap water.

Table 24: Water Supply Sources in the Northeastern Region, 2015

Sources of Water	Number of Households	
	Drinking Water	Water Supply
Tap water	119,407	4,865,939
Purified tap water (boiled/filtered)	378,518	-
Groundwater	98,584	530,089
Well	146,387	75,293
Water from river/canal/ waterfall/mountain	12,492	44,585
Rain water	1,763,176	22,703
Bottled water / water vending machine	3,019,499	
Others	649	224
Unknown	121	-

Source: 2015 Survey on Health and Welfare. National Statistical Office. Ministry of Information and Communication Technology

6. Traffic

195. **NH22 (Nong Han to Phang Kon).** This section of NH22 has an annual average daily traffic (AADT) ranging from 4,500 to 5,500 cars per day. The volume of vehicles increases in the sections where it intersects with NH2280 and NH2091 in Udon Thani and Bungkan and at the intersection with NH222 and NH227 in Sakon Nakhon. Table 25 shows the AADT and its projected growth until 2035 while the Figure 27 presents the AADT within NH22 and other road intersections.

Table 25: Annual Average Daily Traffic (AADT) at NH22 - Nong Han to Phang Kon

Scenario	AADT, vehicles per day					
	2015	2020	2025	2030	2035	% Growth
Without project	11,061	12,307	14,426	16,603	18,573	2.78%
With project	-	12,554	14,974	17,500	19,819	3.09%
Percentage of large vehicles						8.25%

Source: DOH

Figure 27: Annual Average Daily Traffic within NH22 (Nong Han – Phang Kon) and other road intersections

196. **NH 22 (Sakon Nakhon to Nakon Phanom).** The portion of NH22 in Sakon Nakhon to Nakhon Phanom has an AADT of 5,069 vehicles per day as of 2015. The AADT is expected to increase at a rate of 2.87%. By 2035, AADT is projected to increase to 12,848 vehicles per day. With the proposed project, traffic is anticipated to grow by 3.12%. As compared to the traffic at Nong Han – Phang Kon, the daily traffic at Sakon Nakhon to Nakon Phanom is relatively less but there is greater percentage of large vehicles (11.96%) using this road section than at Nong han – Phang Kon (8.25%). The Sakon Nakhon – Nakon Phanom section connects to the Third Thai Mekong International Friendship Bridge at the Thailand border with Laos PDR and serves as an important trading route. Table 26 presents the average annual daily traffic at this section of NH22.

Table 26: Average Annual Daily Traffic at NH22 – Sakon Nakhon to Nakon Phanom

Scenario	AADT, vehicles per day					
	2015	2020	2025	2030	2035	% Growth
Without project	5,068	8,401	10,138	11,632	12,848	2.87%
With project	-	9,082	11,068	12,890	14,395	3.12%
Percentage of large vehicles						11.96%

Source: DOH

197. **NH 23 (Roi Et to Yasothon).** As of 2015, the average annual daily traffic at NH23, along Roi Et – Yasothon is 13,341 vehicles per day. The number of vehicles is protected to increase to 14,625 vehicles per day in 2020 and to 22,760 vehicles per day by 2035. The average growth

rate is 3%. With the proposed road widening project, the AADT in Year 2020 is projected to increase to 17,757 vehicles per day and to 28,052 vehicles per day, using a growth rate of 3.10%. Of the 3 major road sections of the project, the NH23 section in Roi Et to Yasothon has the lowest percentage of large vehicles with 5.22%.

Table 27: Average Annual Daily Traffic at NH23 – Roi Et to Yasothon

Scenario	AADT, vehicles per day					
	2015	**2020**	**2025**	**2030**	**2035**	**% Growth**
Without project	5,068	8,401	10,138	11,632	12,848	2.87%
With project	-	9,082	11,068	12,890	14,395	3.12%
Percentage of large vehicles						11.96%

Source: DOH

V. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

198. Series of public consultation and information disclosure meetings were conducted through the DOH District Offices to provide information to the community on the proposed highway improvements and to gather feedback from the stakeholders about their concerns and views regarding the project so that appropriate measures may be included in the project design. These consultation meetings were supplemented by informal interviews and meetings with local communities and business owners, community leaders, and local government officials.

A. Program of Public Consultation Meetings

199. Nine (9) formal public consultation meetings were organized by DOH for communities within NH22 and NH23 road sections. During these meetings, information about the project background, rationale of the project, design guidelines, and preliminary project design were presented by DOH. A total of 480 participants representing various villages, schools, temples, and local government offices in the vicinity of the project roads attended the consultation meetings. Participants comprise of local people, Buddhist monks, school officials, local government representatives, and roadside vendors.

Table 28: Public Consultation Meetings

Date / Time	Place of Meeting	Composition of Stakeholders	Number of Participants
A. NH22			
March 7, 2017 1:30PM	Nong Kung Village, Phang Khon Tambun, Phong Khon, Sakon Nakhon Province	Villagers and roadside shop owners in Phang Khon	25
March 8, 2017 10:00 AM	Muang Thai Soe, Kusuman sub-district, Sakon Nakhon Province	Governor, local government officials and stakeholders from various villages in Kusuman sub-district	51
March 8, 2017 2:00PM	Sawang Daen Din sub-district, Sakon Nakhon Province	Local government officials, representatives of various villages in Sawang Daen Din sub-district, representatives of schools	59
March 9, 2017 10:00AM	Wong Ta Mua Municipality, Nakon Phanom Province	Representatives from various villages in Wong Ta Mua municipality, Governor and local government officials	74
B. NH23			
March 13, 2017 9:30AM	Ban Niwet, Niwet sub-district, Thawat Buri District, Roi Et Province	Stakeholders from villages in the sub-districts of Thawat Buri, Um Mao, and Phaisan, school officials, and local government representatives	83
March 13, 2017 2:00PM	Thawat Buri District, Roi Et Province	Stakeholders from villages in Thawat Buri district, Buddhist monks, school officials, and local government representatives	46

Date / Time	Place of Meeting	Composition of Stakeholders	Number of Participants
March 14 2017 9:30AM	Non Yang School, Ban Non Yang, Roi Et Province	Stakeholders from Ban Non Yang and surrounding villages, school officials, and local government representatives	41
March 14, 2017 11:00AM	Selaphum Municipal Office, Roi Et Province	Stakeholders from Selaphum Municipality and surrounding villages, school officials, and local government representatives	46
March 14, 2017 1:30PM	Doet Municipal Office, Yasothon Province	Stakeholders from Doet Municipality and surrounding villages, school officials, representatives from the Bodindecha army/military camp, and local government representatives	55

200. During the public consultation meetings, DOH presented the objectives and conceptual plans of the proposed road widening at NH22 and NH23. Possible impacts of the road widening to adjacent communities were also mentioned. The participants were encouraged to raise any social and environmental issues about the proposed project at the end of the project presentation by DOH. Open-ended questions were posed to guide the discussion, such as:

a) What will be the benefits of the road improvement?
b) Do you have any environmental or social concerns with the design of the proposed project?
c) Do you have any suggestions and recommendations that could be considered by DOH in the finalization of the design of the project?
d) Do you have environmental and social concerns and suggestions during construction of the project?
e) Do you have environmental and social concerns and suggestions during operation of the project?
f) Is the area prone to flooding and other climate change issues?
g) Are there important physical cultural resources in the community such as temples that should be protected?
h) Which sensitive receptors such as schools, hospitals, and community areas will be affected by the project?
i) Are there aspects or components of the conceptual plan that should be changed to ensure community safety?

201. The documentation of the consultation meetings is presented in Appendix 3.

B. Results of Public Consultation Activities

202. In general, the communities welcome the proposed widening of NH22 and NH23 because of the benefits on accessibility, safer roads, and the increased economic opportunities. In all the consultation meetings that were held, the stakeholders said that they have no objection to the proposal of DOH and that they have been waiting for the project for a long time. Major issues and suggestions raised by the communities are:

a) provision of pedestrian overpass in front of schools and community areas
b) provision of adequate drainage

c) locating U-turn that are conveniently located in near community areas
d) provision of street lighting, warning signs, traffic lights and bus waiting area
e) minimize tree cutting
f) allow small shops with temporary sheds to continue operating at roadsides
g) allow rice farmers using the ROW to continue planting in 2017 while construction has not started.

1. Specific Issues Raised on NH22 Highway Improvement

203. Table 29 presents the issues and concerns raised by the stakeholders during the consultation meetings held for NH22 with the corresponding responses made by DOH representatives.

Table 29: Issues and Concerns Raised during Consultation Meetings for NH22

Stakeholder Issue / Comments	DOH Response
A. Consultation Meeting at Nong Kung Village, Phang Kong Tambun, Phong Khon, Sakon Nakhon March 7, 2017 1:30PM	
1. When the road is widened, there are safety issues that need to be considered by DOH. The U-turn should be located and designed properly to consider safety. What is the design of the U-turn?	Safety issues will be included in the detailed design of the project. The U-turn will not be elevated. The typical U-turn design was shown to the stakeholders.
2. The road will now have a median barrier and U-turn slot. The proposed U-turn slot might be located far from the village which would make it difficult for the villagers to go to the other side of the road. A cross-over or pedestrian overpass is suggested at the highway.	There is a concern on the provision of elevated pedestrian crossing because some people, especially the elderly, would have difficulty climbing the stairs.
3. In general, the community does not have any objection on the proposed expansion of the two-lane highway to four lanes. The road widening will be good for the safety of the village. However, the villagers need be informed in advance about the schedule of implementation so that they can prepare properly. There are some structures and shops that are on the right of way of the road which need to relocate. The people are willing to move from the right of way but only needs to know when the project will happen.	The detailed design of the project is now being finalized and the construction is proposed by middle of 2017. The DOH is now being required to submit documents to ADB for the processing of the loan.
4. Advance notice should be made to the people at least 3 months prior to start of construction.	Noted
5. What is the distance of the road to be widened from the centerline?	The road widening is 15 – 20 meters from centerline.

Stakeholder Issue / Comments	DOH Response
6. During road construction, can the people still continue selling?	The DOH will discuss this matter with the Provincial Government.
7. Is it possible to construct underground passageway for people?	The underground passageway is more difficult to implement based on engineering requirements.
8. The provision and selection of areas for pedestrian crossing has been discussed several times particularly in areas near schools. This is needed for the safety of children who will now cross wider roads. The community will submit a letter to DOH to officially request for the provision of crossovers in areas with sensitive receptors like schools.	The DOH has policy and criteria for the building of pedestrian crossover. The DOH needs to consult with the community when building crossovers.
9. There are drainage canals which are not functioning properly. Will the roads include the design of the drainage system?	The DOH will incorporate the drainage system. Side drains will be provided.
10. There is no problem on the removal or cutting of big trees in the right of way. The community can just replant trees.	The DOH has undertaken an inventory of trees within the right-of-way. To minimize cutting of trees, the DOH made adjustments in the design to limit the number of trees to be cut. The DOH will present the inventory of affected trees to the Forestry Office.
B. Consultation Meeting at Muang Thai Soe, Kusuman sub-district, Sakon Nakhon March 8, 2017 10:00AM	
1. The community do not have any objection with the proposed widening of NH22. The people have been waiting for the project for a long time. The design of the U-turn should be close to the community and should be particularly near hospitals.	The DOH would like to get the opinion of the community on where to locate the U-turn. The DOH has guidelines on the design of U-turn but suggestions of the community are also considered.
2. The DOH should consider underground system for electrical lines, water supply lines, and other utilities in the design of the road.	The design of underground system for support facilities is not in the current design.
3. The level of the new highway might be higher than the community park. This would cause problems on access to the park.	There will be no changes in the current elevation of the highway.
4. The widening of the highway and provision of median will separate the communities. This will have an impact on	

Stakeholder Issue / Comments	DOH Response
the daily movement of people. Traffic lights should be provided to help the community to cross between two sides of the highway.	
5. What is the status of budget approval? If budget is not sufficient, how will the Government proceed with the project implementation?	The Cabinet has already approved the budget of the project. Additional financial support is being requested from the ADB. The DOH is now preparing the requirements of the ADB for the loan. If the Government budget is not sufficient, the DOH will review the project design again.
6. When will the DOH complete the design of the project?	The detailed design of the project is almost complete with minor modifications. The detailed design should be completed in two months.
7. The existing eight lanes near the market is very short. Will the project include the expansion of the eight lanes? Government should explore using other Government budget for improvement of existing eight lanes such as traffic lights, etc.	This is not included because the budget for the project is only for the expansion of the sections with existing two lanes.
8. The existing drainage canals have difficulty draining water. This should be considered by the DOH in the design.	The project will include drainage canals on both sides of the road.
9. There should be crossover in front of schools for the safety of school children. There should also be a crossover at the police station.	When the detailed design is completed, the DOH will again meet with the community to present the locations of the crossover and U-turn.
10. Underground crossing should be explored by DOH.	People are concerned about the maintenance of underground crossing.
11. Will the road expansion be on one side or on both sides of the existing road?	The road expansion will be on both sides of the road.
12. The community strongly supports the project. The DOH needs to consider the suggestions of the community in the detailed design and present the detailed design again. *The people showed support to the project by raising their hands when asked by the Governor whether they support the project.*	
13. How long is the construction period?	Construction will take place for about two years.
14. The detailed design should consider the impacts to the community when the level of the highway is higher than the elevation of the houses.	This will be considered in the design of drainage canals.

Stakeholder Issue / Comments	DOH Response
15. The project will likely cause problems on linkages of villages and drainage issues. However, the community acknowledges that the quality of life of the people will be better with the proposed project. It will boast tourism and increase income of the community because more tourists will be coming to the area. The community look forward to the implementation of the project soon.	
16. In case, ADB will not approve the loan, how will the Government finance the project?	The project has been approved by Cabinet. The Government will find ways to implement the project.
17. Kusuman sub-district experience flooding in some areas. The drainage system should be considered in the detailed design of the road.	This is included in the design of the project.
C. Consultation Meeting at Sawang Daen Din sub-district, Sakon Nakhon March 8, 2017 2:00PM	
1. When is the start of project implementation?	The detailed design of the project has been prepared but there are still some modifications. The designed design should be completed in May.
2. There are teak trees that should be conserved within the road. The DOH should minimize the cutting of trees. It is acknowledged that in the past, the DOH has been planting trees instead of cutting trees.	The width of the road has been adjusted in some sections to minimize cutting of trees.
3. There are no significant environmental impacts that are anticipated as observed from previous road construction activities. The community is expecting DOH to implement the project soon because of the benefits that will be realized. Logistics will also be enhanced because of the road widening project.	
4. Will the project include the existing roads with four lanes?	The project will widen the sections with two lanes.
5. The project should consider the safety of the community.	The DOH has been looking at sensitive receptors as part of the requirement of the ADB. Impacts on sensitive receptors will be considered such as provision of crossover bridge in schools. The DOH recognizes the impact on safety of school children and will include the crossover in the detailed design.
6. The Governor of Pantain sub-district said that the existing road has no median and that there is no clear point for U-turn	The DOH has guidelines and criteria on selecting locations of U-turn. This is based on traffic volume and other factors.

Stakeholder Issue / Comments	DOH Response
which compromises safety of the community. The right location of the U-turn should be selected particularly in Pantai sub-district where accidents happened in the past.	
7. The Chief of Banten sub-district said that the design of the project should include improvement of drainage.	The section of the road in Banten sub-district is already four lanes and is not included in the project.
8. There are sections along the road with damaged drainage canals. The final design should consider these canals.	The DOH district office surveyed the right of way together with the engineering team. The initial design was to widen the road only on one side but because of the concerns on the drainage canal, the design of the road now includes expansion on both sides to include the provision of side drains. The number of pipes will increase. The DOH will ensure that the drainage is designed properly.
9. Cutting of teak trees should be minimized.	The final number of affected trees will be available soon based on detailed design which minimized cutting of trees.
10. The school in Nong Kung is adjacent to the road. Safety issues should be considered by the DOH.	The DOH acknowledges the safety issue which is a key consideration because cars tend to drive faster in four lane roads than in two lane roads.
11. There should be elevated flyover in areas near schools. The cost may be higher for elevated flyover but this should be explored by DOH if necessary in certain areas with sensitive receptors.	
12. There are areas with shops along the road. Can the villagers still continue selling?	The DOH conducted consultation meeting with villagers in Nong Kung. The matter is being referred to the province. There is a suggestion for assistance in relocating the shops and also to build a small road near their shops.
D. Consultation Meeting at Wong Ta Mua Municipality, Nakon Phanom Province March 9, 2017 10:00AM	
1. The community is pleased with the expansion of the highway from two lanes to four lanes. However, it is important for DOH to consider a good position of the U-turn slot that is not far from the village.	The DOH already prepared the detailed design but there are still modifications on the design.
2. There is no problem if the widening of the road will require cutting of trees. These	Noted.

Stakeholder Issue / Comments	DOH Response
are ordinary trees which the villagers can replant after completion of the project.	
3. The provision of the elevated median will hamper movement of motorcycles because they will not be able to cross easily to the other side of the road. Representatives of Ban Kan Sawan and Ban Pon Cha Roen particularly requested that the elevated median be excluded from the project design and instead be replaced by the flat median.	The elevated median is designed to mitigate safety issues and protect the general public from road accidents. Without the center island, there is no clear barrier between the two opposite lanes and more accidents might occur. The DOH will study the appropriate location of the U-turn to ensure convenience of the villagers. The U-turn will be designed in accordance with design standards for highways. During the final detailed design, the DOH will present the project again to the villagers for comment on the locations of the U-turn.
4. There should be crossover in front of schools to ensure safety of school children.	The DOH is committed to providing the crossover in sensitive areas like schools. The DOH will consider the views of the people on where to locate the U-turn and crossover.
5. There should be temporary sheds for bus stops.	The DOH will provide these waiting sheds along the road. The final design will be presented again to the community showing the locations of the waiting sheds.
6. There is a school in Ban Mahasai that will require a crossover. Some villages have two schools that need crossovers while in some villages there are schools that do not require a crossover because the village and the school are on one side of the highway.	Noted.
7. Majority of the area do not experience flooding. There are also no problems in drainage in the area.	Noted.
8. Will the project include street lighting and traffic lights for road safety?	To be designed.
9. The municipal head ascertained that the community does not have any objection with the road widening project. He added that people can still raise their suggestions on the detailed design to be finalized by DOH. *The people raised their hands to show support to the proposed project.*	Noted.

Stakeholder Issue / Comments	DOH Response
10. The villagers need to see the detailed design from DOH so that people can comment and make suggestions on the location of the U-turn and traffic lights.	Once the detailed design is completed, the DOH will again call a meeting with the villagers to present the design and locations of the U-turn, crossover, and traffic lights and to get their final comments on the design before it is implemented.
11. There is a historical place located about 2 km away from the road. Lighting on the road is necessary for the safety of the people.	Noted.

2. Specific Issues Raised on NH23 Highway Improvement

204. The following presents the issues and comments raised by the stakeholders during the consultation meetings and the corresponding responses made by DOH.

Table 30: Issues and Concerns Raised during Consultation Meetings for NH23

Stakeholder Issue / Comments	DOH Response
A. Consultation Meeting at Ban Niwet, Niwet Sub-district, Thawat Buri District, Roi Et Province March 13, 2017 9:30AM	
1. There might be flooding at the depressed median.	The design of the depressed median will ensure that flooding will not occur at the median. Culverts will be provided.
2. Will there be cutting of trees at roadsides of Ban Pratoochai?	Inventory of trees was already completed by the DOH. This will be submitted to Department of Forest.
3. Will there be trees in the median?	There will be no trees at the median.
4. Pedestrian overpass should be provided at community market, schools and community areas. The overpass should be built at the same time with the construction of the road.	Location of pedestrian overpass will be evaluated in the detailed design.
5. There will be dust, noise and traffic during construction but this will be temporary impacts and can be mitigated. These temporary disturbances can be tolerated by the community.	Noted.
6. The consultation organized by the DOH before the project implementation is appreciated.	Noted
7. When is start of construction?	The detailed design is now being finalized. Subcontractor is not yet identified. Possible start of construction is early 2018.

Stakeholder Issue / Comments	DOH Response
8. The road should have traffic lights.	The DOH is following a design criterion in locating traffic lights. Communities will also be consulted on suggested locations of traffic lights.
9. Can the people still sell by the roadside?	Selling within the ROW is illegal but temporary sheds for shops are being allowed by DOH.
10. Can people cultivate rice by the roadside before start of construction? DOH should give advance notice so that rice cultivation will not be done anymore.	DOH will give sufficient time so that the people will no longer plant at the roadside when the project is ready to implement.
11. Will DOH provide access to houses?	Access to houses from the roads will be the responsibility of the owners.
12. Some people were able to get titles along the ROW.	The ROW is owned by DOH according to the law. The information about land titles in the ROW will be validated by DOH.
13. There should be road lighting in sensitive areas. Sometimes street lights are off at night.	Street lights will be provided by the project.
14. What is the hotline number of DOH to report any complaints or issues?	Hotline number no. provided.
15. Give attention to drainage in Unit 67 of Ban Niwet because of clogged drains. Drainage should be built at the same time as the road construction.	The DOH met with the municipality to discuss the drainage design. Side drains are blocked by property owners. Drains will be built at the same time as the road widening.
16. Motorbike will have difficulty crossing on depressed median.	The depressed median is designed for road safety. U-turn will be designed for vehicle crossing.
B. Consultation Meeting at Thawat Buri District, Roi Et Province March 13, 2017 2:00PM	
1. Will the DOH remove the existing road?	The new road will be built adjacent to the existing road.
2. Where is the location of the U-turn?	DOH will follow the criteria in selecting location of the U-turn. DOH will consider the needs of the community.
3. There should be area of cattle crossing.	Special path for animals such as underground culvert will be evaluated.
4. Pedestrian crossing should be in front of temples and schools.	To be evaluated in the detailed design
5. What is the duration of construction?	Two years, but could be affected by rainy season. Construction may begin in March 2018.
6. There are accidents at existing two lane highway because it is narrow with lots of vehicle traffic. The road widening is needed as soon as possible.	Noted

Stakeholder Issue / Comments	DOH Response
7. There should be sufficient street lights.	Street lights will be provided.
8. Cutting of trees at the roadside	DOH conducted an inventory of affected trees in the ROW. This will be submitted to the Department of Forest to secure clearance on cutting of the trees.
9. There is a proposed zoo in the next district which could produce more traffic.	Noted
10. There are rice paddies within the ROW.	People were allowed to plant for several years already. They need to give up the rice paddies when the road construction begins.
11. Difficulties during construction such as dust and noise are only temporary. The people do not see these as major concerns.	Noted.
12. There are small shops on the roadsides that may be affected.	DOH will conduct an inventory of the shops and discuss with affected shop owners.
13. Some people were able to acquire land titles within the ROW.	DOH is the owner of the ROW in accordance with the law. The land titles will be validated.
14. During heavy rains, water at Chi River almost reach the bridge but did not cause flooding in the vicinity.	Noted.
C. Consultation Meeting at Non Yang School, Ban Non Yang, Roi Et Province March 14, 2017 9:30AM	
1. The widening of the road may cause possible impacts on safety during construction.	There DOH prescribes a safety protocol to be followed by contractors.
2. How far from existing road is area to be affected?	The DOH will use the ROW only, at least 12-15 meters from the end of existing road. This is still within the ROW of road. The contractor needs to follow environmental and social measures and make sure that they comply with the requirements of the Government and ADB. Asking consent of the villagers adjacent to the roads will be an important task of the contractor.
3. A stakeholder said that she was not compensated and that the Department of Land refused to grant her a title for land beside the existing road.	The ROW was acquired by the DOH about 40 years ago which could be the reason why the Department of Land refused to grant a land title.
4. DOH should inform the people about the start of construction.	DOH will give advance notice.

Stakeholder Issue / Comments	DOH Response
5. In the future, it will be difficult for people to cross the road because it will become wider.	There will be U-turns which will follow the standard design criteria on safety. The location of the U-turn will be presented to the community.
6. There are trees that will be cut on the roadside. Can the villagers use the logs?	The DOH will report the inventory of affected trees within the ROW to the Department of Forest (DOF). People cannot use the cut logs because the DOF will handle the cutting of trees and dispose the logs through auction.
7. How can people travel the road during construction?	DOH will make sure that traffic will continue during construction.
8. In the village, there are about 100 heads of cattle. How can cattle cross to the other side of the road? There should be cattle pathways because the U-turn might be too far. Can DOH make a tunnel or underpass for cattle and also for bicycles?	The median for NH23 has been designed as the depressed type and not the elevated median which can allow cattle crossing. The suggestions will be evaluated by DOH. The DOH asked the people to also observe road safety and manage their cattle because when the road is widened there will be faster cars on the road.
9. How far is the road widening from the fence of Non Yang School? Construction might damage the fence because of vibration.	Construction will be about 15 m from the fence of the school.
10. Can people planting rice on the roadside continue rice cultivation this year?	Contractor bidding will be in October so planting in 2017 is not a problem.
11. The natural waterway in the past drains quickly. Now there are clogged waterways. The culverts should be wider and villagers should stop putting materials that block the waterways. The stakeholders said that during the wet season, there is no overflow from the Non Yang reservoir.	This will be discussed with other departments managing waterways to improve drainage flow.
D. Consultation Meeting at Selaphum Municipality, Roi Et Province March 14, 2017 11:00AM	
1. Where is the exact location of the road to be widened? What is the elevation?	The road widening will be adjacent/connected to existing road and will be of the same elevation.
2. Where are the locations of the U-turn and road crossing? U-turn should be located near community centers/villages.	There will be pedestrian overpasses and U-turns to ensure road safety. There is a design criteria being followed by DOH for the U-turn. The locations of these facilities will be presented to the community when the detailed design is completed.
3. Cattle cannot cross the road when the road is widened to four lanes.	DOH will take this into consideration. Possibility of tunnel for cattle will be evaluated.

Stakeholder Issue / Comments	DOH Response
4. There should be sufficient lighting at night especially at intersections.	This will be considered in the detailed design.
5. In front of Ban Bak, there is a road curve where accidents happen. This dangerous curve should be evaluated by DOH.	To be evaluated by DOH.
6. Can the villagers still continue planting by the roadside?	The estimated start of construction is April 2018. People can still plant rice in 2017.
7. When burying the dead, there is a culture in the locality not to make a U-turn.	Other access will be evaluated.
8. In Ban Bak, there are several Yang trees located about 20 – 30 meters from the center of existing road.	The DOH has conducted an inventory of affected trees. Some of the trees can be preserved because they are outside the ROW. The DOH will follow the procedure of the Department of Forest (DOF) on cutting trees.
9. There should be an overpass at Ban Bak school.	To be considered in detailed design
10. What is the design of the drainage?	There will be side drains and culverts that are connected to the depressed median.
11. There should be signs near schools.	Road signs will be posted near schools.
12. During construction, will the DOH provide access paths to schools?	There will be temporary paths/access to schools and other public properties to be provided by the project but not for private properties.
E. Consultation Meeting at Doet Municipality, Yasothon Province March 14, 2017 1:30PM	
1. Cattle and buffalos cross the road. Will there be a prescribe time for cattle to cross the road?	There is no special time for animals to cross the road. The owners of cattle should make sure that animals being herded will not cause hazard to traffic. DOH will provide signs in areas with animal crossing.
2. The trees in front of the Bodindecha military camp do not belong to the camp. The military will refer the matter to the Department of Forest (DOF).	The trees are within the ROW of the road. DOH has already informed the DOF. DOH will also inform the military camp when it is time for the DOF to cut the trees. DOF will implement the tree cutting through auction.
3. Accidents happen in 2 – 3 dangerous areas along the road. These sections should be investigated by DOH.	This will be evaluated by DOH.
4. There should be U-turn or overpass particularly near schools.	Every 2 km there will be one U-turn.
5. The stretch of the road along the military camp is about 2 km. Will there be 2 U-turns in the vicinity of the military camp?	The DOH is now preparing the detailed design. The location of U-turn will follow the design criteria. The U-turn are preferably near hospitals and main consideration is road safety.
6. There should be traffic lights at U-turn.	To be evaluated in the detailed design.

Stakeholder Issue / Comments	DOH Response
7. The local school has about 500 students. There should be visible road signs. Overpass may not be necessary because students use public transportation and only few students walk to school.	The road signs will be provided. Pedestrian overpass for the school will be evaluated.
8. Will the road be elevated? Water might drain towards properties. DOH should take into consideration the drainage and flow of water into the reservoir.	Drainage will be about 1.2 meter deep. Villagers should not block the drainage when building access to properties. Water on road surface is a cause of accidents so residents should not block the flow of drainage when building access to houses to avid water ponding on the road.
9. Can the median be painted median only?	In narrow areas, the median is flat and narrow but the ROW of NH23 is wide so the median is also wider. The depressed median will limit accidents.
10. Will DOH provide access to houses and agricultural areas?	DOH will provide access to public areas but not for private properties.
11. Detailed design of the road showing the locations of the U-turn and pedestrian overpass should be presented to the community.	When the detailed design is completed, DOH will present this to the community. The current public consultation aims to gather comments and views of the people.
12. The DOH should retain some of the trees on the roadside.	The DOH surveyed the trees to avoid some trees to be cut.
13. There should be sufficient street lights on the road.	Street lights will be provided.
14. In Ban Kham Daeng, there is a curve and slight slope which caused accidents in the past. There should be a U-turn close to the existing access.	To be evaluated for the detailed design.

C. Future Plans for Information Disclosure and Public Participation

205. As a follow-up to the public information disclosure and consultation activities, there will be subsequent public information activities to notify local communities, individuals and other affected parties on the following issues:

a) Location of U-turns and pedestrian overpass that are acceptable to the community
b) Construction operations and schedules
c) Notification on temporary access restrictions for affected households, businesses, and other establishments and mitigation measures to address this issue
d) Traffic management plans
e) Cutting/removal of affected trees.

206. These follow-up activities will be undertaken by the PMU in coordination with the DOH District Offices. These will be through individual meetings with affected households, businesses and establishments as well as coordination meetings with concerned government offices and local officials. The following are the planned follow-up consultation activities and disclosure measures.

Table 31: Planned Consultation Activities and Disclosure Measures on Environment Safeguards

Objective	Target Audience	Means of Communication	Responsibility	Timing
Disclosure of draft IEE with EMP and monitoring plan	Public at large	Uploading to ADB/DOH website	DOH	Before MRM
Inventory of affected trees based on detailed design	Provincial Forest Department, Provincial Natural Resources and Environment Office (PONRE), Forest Industry Organization	Project information and inventory of affected trees, Meetings Site inspection Tagging/marking of affected trees	DOH District Offices	Design Phase
Consultation on location of U-turns and pedestrian overpass	Villages, sensitive receptors (schools, hospitals, temples/churches) within the ROW	Meetings	DOH Design Team DOH District Offices	Design Phase
Temporary access restriction	Affected households, businesses, agricultural land, and other establishments	One-on-one meetings/consultation	Contractor PMU	Prior to start of construction
Traffic management plan	Provincial Office, villages	Meetings	Contractor PMU DOH District Offices	Prior to start of construction
Construction activities and schedule	Provincial Office, villages	Meetings	Contractor PMU DOH District Offices	Prior to start of construction
Disclosure of monitoring reports	Public at large	Uploading to ADB/DOH website	DOH PMU	Semi-annual; within 1 month after report is submitted

VI. GRIEVANCE REDRESS MECHANISM

207. Grievances are issues, concerns or complaints that may be raised by stakeholders about the implementation of the project. There is an existing grievance redress mechanism (GRM) that has been established by the DOH and the local government. The GRM provides a systematic process for receiving, validating, and resolving complaints from affected people and is designed to achieve the following:

a) serve as an open channel for effective communication of environmental issues and concerns arising from the project
b) allow prompt action or resolution of any complaint or adverse environmental impacts that may occur during project construction and operation
c) serve as a means to hear community suggestions on the project
d) promote transparency in project implementation.

208. Any affected person may raise and submit a grievance if the activity has detrimental impact on the environment, the community, or the quality of life of the people. Examples of grievances are hazards to community health and safety; construction-related nuisances such as noise and dust and improper disposal of wastes; adverse changes on way of life and livelihood; peace and order problems due to presence of migrant workers; and failure of the project to comply with environmental policies, safety clearance requirements, and other legal obligations.

A. Modes of Receiving Grievances

209. There are six (6) common routes wherein a complaint or grievance may be lodged about the project. These routes of entry are either through (i) project engineer and/or construction project office, (ii) DOH District office, (iii) DOH complaints center which is accessible through the DOH website (http://complain.doh.go.th/complain/index.php), (iv) DOH Hotline 1586, (v) complaints center called Damrongdhama Centre at the Department of Local Administration, and (vi) a separate Damrongdhama Centre at the provincial government office. The project engineer, being the focal person for the GRM and all matters related to construction management, will notify the village head about the complaints.

210. Contact numbers will be shared to the stakeholders to emphasize the immediate route by which complaints or concerns can be raised by the public about the project. Other entry points and modes of access are through face-to-face meetings with the DOH, written complaints, and telephone call at DOH district offices. An Information Board visible to the community will be posted at the construction site to provide the project information and to update the public about the ongoing project activities including the contact person and number of the DOH where grievances could be raised.

B. Grievance Resolution Process

211. In compliance with the requirements of Constitution of the Kingdom of Thailand B.E. 2550 (2005), ADB SPS (2009) and the ADB Public Communication Policy (PCP, 2012), the project shall comply with the requirements on public consultation and information disclosure. Meaningful consultation with affected people and other concerned stakeholders, including civil society, was conducted to present the proposed project at the early stage of project planning and implementation. This enabled DOH to hear the views of affected people and stakeholders for

consideration in the finalization of the project design and to identify appropriate mitigation measures. The consultation process proceeds on an ongoing basis throughout the project cycle.

212. During project construction, the Project Engineer under the PMU will be responsible in receiving and handling complaints or query regarding the project. Once the project is turned-over to the DOH District offices for maintenance and operation, the assigned focal person of the DOH District will be in-charge of managing the GRM.

213. **Management of Grievances.** A community member can approach the Project Engineer for complaints or query. Although several channels of communication exist, contacting the Project Engineer directly is the most efficient way to address the grievances. The focal person at the project's construction office will maintain a Record Book to track the following details:

a) date of the complaint
b) details of the complainant such as name and contact information
c) description of the grievance
d) action taken
e) follow-up requirements (if any).

214. The Project Engineer should be able to immediately contact the affected person to discuss the nature of the complaint and the actions to be undertaken to resolve the complaint. Any complaint filed or raised should be immediately resolved as soon as possible. Matters that can be dealt with immediately should be resolved within 7 working days upon receipt of the complaint while some matters that entail modification to the construction contract or require higher level approval may take longer to resolve. Apart from complaints filed directly to the Project Engineer, those that are submitted to other channels of DOH, i.e. District Office, Hotline 1586, DOH website, will be transferred to the PMU and subsequently to the Project Engineer for resolution. If the complaint is not satisfactorily resolved by the project, the affected person can use the Government's GRM.

215. Following the grievance redress procedures that was established by the Government, e.g. local level Damrongdhama Center, the inquiry will be sent to the Project Engineer for verification and resolution. For matters that need verification with the involved members of the community, the Project Engineer will consult with the village head or natural leader for validation and deliberation. During this process, the village head may discuss with the affected person, or setup a meeting among the community members, along with Project Engineer and the contractor to discuss the resolution of the grievance. The Project Engineer shall be responsible in coordinating with the affected person and the village head in taking actions towards the resolution of complaints. A construction-related complaint will be promptly referred to the contractor for resolution while the PMU will monitor the mitigation measures implemented by the contractor with a view of avoiding recurrence of the problem. Based on practice, complaints are resolved at the village level and no longer go through the next level of the executive branch of the government.

216. If the complainant is still not satisfied with the actions undertaken to resolve the complaint, he/she may file the complaint with the Provincial Damrongdhama Centre who will conduct further investigation of the grievance and call on the affected person, PMU/DOH District, and the contractor to discuss the resolution of the complaint.

217. If the grievance remains unresolved after going through the hierarchy of the local government's grievance redress process, the affected person has the option to elevate the case to the judicial body.

218. **ADB's Accountability Mechanism.** In addition to the project GRM, ADB's accountability mechanism (May 2012) also applies to the project. The accountability mechanism provides opportunities for people that are adversely affected by ADB-financed projects to express their grievances, seek solutions, and report alleged violations of ADB's operational policies and procedures, including safeguard policies. ADB's accountability mechanism comprises of (i) consultation led by ADB's special project facilitator to assist people adversely affected by ADB-assisted projects in finding solutions to their concerns and (ii) providing a process through which those affected by projects can file requests for compliance review by ADB's Compliance Review Panel.

VII. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

219. The environmental impacts were identified based on the issues related to the project components and location and also from the activities during road construction and operation. The identification of environmental impacts was mainly based on the information about the project design, field visits, results of public consultation, and information gathered from Government representatives.

A. Methodology for Impact Analysis

220. The identification, prediction and evaluation of the potential environmental and social impacts have been undertaken on the basis of the baseline and secondary data at the project affected sites. A number of impact assessment criteria were used to determine the significance of the impacts. As presented in Table 32 these include type of impact, spatial extent, temporal context, and magnitude. For every project activity identified, expected impacts are identified and rated for their significance using these criteria.

Table 32: Assessment Criteria Used in the Determination of Impact Significance

Assessment Criteria	Definition	
a. Nature		
Positive (+)	Effect has a net benefit to the biophysical or socio-economic conditions.	
Negative (-)	Effect has a net loss or is a detriment to the biophysical or socio-economic conditions.	
b. Spatial Extent – Location of Effect		
Direct impact zone (Footprint) - D	This is the project footprint or the land area directly disturbed by the project including batching plants, waste disposal sites, construction camps and associated physical works, and road operations up to about 100 meters from the project area.	
Indirect impact zone - IN	The area extending beyond the footprint (adjacent communities and land) that will be potentially disturbed by the project including batching plants, waste disposal sites, construction camps, and associated physical works and road operations.	
Temporal Context		
Duration (period of the event causing the effect)	Short-term (ST)	Event occurs during the extent of construction.
	Long-term (LT)	Ongoing event that extends greater than the construction period.
Frequency (how often would the event that caused the effect occur)	Accidental (A)	Event occurs rarely over the life of the Project.
	Isolated (I)	Event is confined to specified Project activity(ies).
	Occasional (O)	Event occurs intermittently and sporadically over the life of the Project.

Assessment Criteria	Definition	
	Periodic (P)	Event occurs intermittently, however repeatedly over the life of the Project.
	Continuous (C)	Event occurs continually over the life of the Project.
Magnitude		
Negligible	No detectable change from existing (baseline) conditions.	
Low	Change is detectable and results in a limited effect on the environmental or social component.	
Medium	Change is detectable and results in a moderate effect on the environmental or social component.	
High	Change is detectable and results in a severe effect on the environmental or social component.	

221. The proposed project will inevitably create various impacts on the surrounding environment and local population during the construction and operations phases. Based on the analysis of the key environmental and social impacts that may arise from the widening of sections of NH22 and NH23, the notable adverse environmental impacts include the removal of trees, community and workers safety and generation of dust and noise during construction and potential hazards to community safety due to increased movement of vehicles once the project is operational. The impacts on the physical and human environment during construction will be low to moderate and can be mitigated through implementation of appropriate mitigation measures. Adverse construction impacts include dust, noise, vibration, soil erosion, and generation of construction waste materials. Adverse social impacts include the temporary disruption of access to properties and community services and community hazards caused by excavations, movement of construction vehicles, and other related construction activities. Table 33 summarizes the identified environmental and social impacts that may be created based on the project's various activities with suggestions for mitigation of adverse impacts. A full discussion of the mitigation measures for projected impacts are described in Chapter VIII – Environmental Management Plan.

Table 33: Assessment of Project's Environmental and Social Impacts

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
Physical Resources								
Air Quality	Digging, excavation, materials transportation and other construction activities	Dust is not expected to occur frequently and at high magnitude. Affected area may reach a distance of about 50 meters around project sites.	-	D	ST	I	M	Conduct water sprinkling and other dust control measures indicated in Chapter VIII – Environmental Management Plan.
	Bitumen application and spreading	Odor emission will be confined within the construction areas and will not spread to community areas.	-	D	ST	I	L	Provide workers with PPEs. Implement bitumen application when there is less people near the road; Avoid school arrivals/departures, temple/church services and market day. Other detailed mitigation measures are outlined in Chapter VIII.
Hydrology and Water Quality	Earthworks	Area is in relatively flat to moderate terrain. Erosion and sedimentation may occur at sloping terrain and at bridge areas at Chi River and Yang River.	-	D	ST	I	L	Implement suitable soil erosion control measures. Specific measures are presented in Chapter VIII – Environmental Management Plan.

[25] The complete list and detailed discussion of the mitigation measures are presented in Chapter VIII – Environmental Management Plan.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
	Drainage management	The project construction may cause clogging of side drains that would result to flooding. The impact is considered of low magnitude since the project includes the provision of drains and culverts.	-	D	ST	I	L	Provide adequately sized side drains and culverts. Avoid spill of construction materials into canals.
	Equipment maintenance	Oil spill could lead to contamination of land but the impact is considered insignificant because of low quantities of oil to be stored and utilized by the project.	-	D	ST	I	L	Design and implement an oil spill contingency plan.
	Construction activities	Generation of construction wastes such as domestic solid wastes, inert and hazardous wastes would result to low to moderate impacts. DOH has reserve areas for inert construction wastes.	-	D	ST	I	L/M	Implement a solid waste management plan at construction sites, camps, and other associated facilities.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
	Operation of construction camps	Generation of domestic sewage that could lead to discharge of polluted water into surface and ground waters. The impact is insignificant because of the low magnitude of sewage and the provision of wastewater treatment methods.	-	D	ST	I	L	Provide temporary toilets with septic tanks. Measures to management impacts of construction camps are presented in Chapter VIII – Environmental Management Plan.
Ecological Resources								
Protected area	-	There are no activities in protected areas. The nearest protected area is about 30 km away.						Not applicable. The road widening project will be within established road ROW.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
Flora	Cutting of trees	There are 1,879 trees in the road ROW of NH22 and NH23 which includes 38 Mersawat Kesat and 274 Yang Na trees which are both considered as endangered under the IUCN Red List.	-	D	LT	I	M	Conduct tree inventory, identify and mark the trees to be cut and comply with the requirements of the Royal Forest Department. Minimize tree cutting by adjusting road design without compromising road safety standards. From an initial inventory of 1,420 affected trees at NH22, the number of affected trees was reduced to 535 trees due to adjustments in the design of the road ROW and median. There are no changes at NH23 due to limitations in the road ROW. Implement tree earthballing. Prepare a tree landscaping and replanting plan.
Aquatic Ecology	Bridge works	The project runs through Chi River and Yang River. Biodiversity is not abundant because river water only passes through agricultural fields and community areas.	-	D	ST	I	N	Sediment trap / oil trap is needed when working near rivers.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
Human Use Values								
Land values	Clearing of road ROW affecting current roadside activities and structures	Loss of productive land inside the ROW	-	D	LT	I	L	Notify affected farmers about schedule of project implementation. A Resettlement Plan is being prepared for the project.
		Economic displacement on shops	-	D	ST	I	L	Notify affected shop owners about schedule of project implementation. A Resettlement Plan is being prepared for the project.
		Temporary impacts on driveways, parking lots, and community facilities	-	D	ST	I	L	Notify affected persons/property owners/utility companies about schedule of project implementation. Provide temporary access to owners of affected structures and facilities. Coordinate with relevant authorities regarding the relocation of affected utilities. Restore damaged structures.
Noise and vibration	Breaking of sections of existing road surfaces; operation of construction equipment	Nuisance to sensitive receptors located along the ROW will be low to moderate. Construction activities move along the highway alignment as work progresses.	-	D	ST	I	M	Regulate noisy construction activities at night particularly in areas with sensitive receptors.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
	Vehicle movement along NH22 and NH23	The surrounding land use is primarily wide agricultural land and sensitive receptors are located with enough distance from the road ROW. Projected noise levels will increase by 1 dB(A) by 2040 at all road sections from increased road traffic.	-	D	LT	O	L	Implement regular road surface maintenance to minimize noise caused by poor road pavement. Provide noise barriers and other noise mitigation measures when noise monitoring trends indicate exceedance to the WB-EHS noise standards that affect noise sensitive receptors along the roads.
	Operation of roads	Improvement of trade and cooperation with neighboring countries	+	IN	LT	C	H	
Community health and safety	Presence of construction operations near community areas.	Accidents and hazards to commuters and passersby during road construction will cause low to moderate impacts to the community.	-	D	ST	A	L/M	Provide warning signs, barricades, steel plate covers on excavations and warning signs.
		Road traffic may occur because of construction activities but at low magnitude.	-	D	ST	I	L	Install information boards about future and ongoing construction activities. Implement a traffic management plan.

Topic	Activities / Aspects	Environmental Impacts	Nature	Spatial Extent	Duration	Frequency	Magnitude	Mitigation[25]
	Operation of roads	Increased road traffic may lead to more road accidents particularly in front of schools and community areas and will cause significant risks to community safety.	-	D	LT	A	M	Provide road infrastructures such as pedestrian overpass in front of schools and community areas, clear warning signs, traffic signals, street lights, etc.
		Physical barrier to animal crossing will not cause significant impact because depressed median or low raised median was designed in areas where reported animal crossing is frequent.	-	D	ST	O	N	Design of median was adjusted in areas with animal crossing. Animal crossing signs including an information education awareness program for herders will be necessary.
Occupational health and safety	Construction activities	Hazards during construction will cause low to moderate impacts on worker safety.	-	D	ST	I	L/M	Require contractor to implement a Construction Health and Safety Plan.
Cultural and archaeological sites	Construction activities near temples	Construction activities may affect religious practices. The impact is considered insignificant with proper planning and coordination with local authorities.	-	D	ST	I	L	Coordinate with local authorities.

B. Anticipated Benefits from the Project

222. The upgrading from 2-lane road to 4-lane road is in line with Thailand's Eleventh National Economic and Social Development Plan, 2012-2016. The proposed project aims to provide better connection to different regions of the country and between major cities and main towns. The upgrades on NH22 and NH23 will also promote international trade and cooperation between Thailand, Laos People's Democratic Republic (Lao PDR), Viet Nam and the People's Republic of China (PRC) through development of efficient road infrastructures that are linked to neighboring countries. The project is expected to help promote development of economy, trade and industry and bring forth more investment and employment opportunities. The road widening will also accommodate anticipated future traffic growth.

223. In general, the widening of NH22 and NH23 is expected to result to improved convenience, speed and safety on these roads and enable the system to accommodate more traffic.

C. Pre-Construction Activities to Mitigate Anticipated Impacts

1. Design Considerations

224. The project design team took into account the following considerations: (i) engineering soundness; (ii) traffic volume, (iii) community areas and road junctions, (iv) road safety, (v) flooding and drainage, (vi) cutting of trees, (vii) impacts on workers, (viii) stakeholder opinions and suggestions, (ix) health effects, and (x) environmental problems on water quality and air quality.

225. **Impacts on Current Roadside Activities and Structures.** There are shops, driveways, parking lots, and agricultural rice land within the ROW. Impacts would include (i) loss of use of productive land inside the ROW; (ii) economic displacement on shops; and (iii) temporary impacts during construction on driveways and parking lots. Some farmers who are using the ROW to grow rice requested that they be allowed to plant rice this year (2017) while construction has not started. Meanwhile, the owners of shops within the ROW said that they would just transfer their business elsewhere in the vicinity. An assessment of the resettlement impacts is being undertaken separately and a Resettlement Plan is being developed to ensure measures for affected persons are properly managed.

226. **Cutting of Trees.** The DOH aims to minimize the potential environmental impacts by ensuring that the widening of the highway is within the ROW, which was established through a Royal Decree in 1968. The project will not traverse any ecologically sensitive area and the vicinity of the existing NH22 and NH23 is generally considered as disturbed habitats. However, the road widening will require the clearing of existing trees within the established ROW, of which majority were planted by DOH within the ROW to prevent illegal encroachment. The DOH design team through the DOH District Offices conducted an inventory of trees within the road ROW.

227. Based on the initial inventory of trees, there will be a total of 1,879 trees within the 60-meter ROW of NH22 and NH23 that will be affected by the road expansion. Majority is considered as "Least Concern" or "Not Evaluated" under the International Union on Conservation of Nature (IUCN)[26] Red List. However, there are two species: (i) *Anisoptera costata Korth* and (ii)

[26] The IUCN is a global taxon assessment that is recognized as a guide by numerous governmental and non-government organizations to determine species at high risk of extinction and which require appropriate conservation measures.

Dipterocarpus alatus Roxb. Ex G. Don (*Yang Na*) which are in the Endangered category of the IUCN.

228. The IUCN Red List entry for Yang Na and Mersawa kesat was made in1998 and needs updating as indicated in their web site. It used the IUCN Red List Categories and Criteria (version 2.3) under which the following explanation was provided in the Preamble section:

> *1. "…The categorisation process should only be applied to wild populations inside their natural range,.." and*
>
> *11. Use at regional level*
> *The criteria are most appropriately applied to whole taxa at a global scale, rather than to those units defined by regional or national boundaries. Regionally or nationally based threat categories, which are aimed at including taxa that are threatened at regional or national levels (but not necessarily throughout their global ranges), are best used with two key pieces of information: the global status category for the taxon, and the proportion of the global population or range that occurs within the region or nation. <u>However, if applied at regional or national level it must be recognized that a global category of threat may not be the same as a regional or national category for a particular taxon.</u> For example, taxa classified as Vulnerable on the basis of their global declines in numbers or range might be Lower Risk within a particular region where their populations are stable. Conversely, taxa classified as Lower Risk globally might be Critically Endangered within a particular region where numbers are very small or declining, perhaps only because they are at the margins of their global range. IUCN is still in the process of developing guidelines for the use of national red list categories.*

229. IUCN's Red List categorization is based on a global scale (not just Thailand) and applies to populations in the wild. The trees in the ROW however were planted by DOH. Despite their inclusion in the IUCN Red List, information from the Provincial Forest Departments and from stakeholders during public consultations however indicates that Yang Na, Mersawa Kesat and teak are tree species common in northeastern Thailand. Appendix 5 (News Articles and Clippings on Tree Planting and Conservation in Thailand) show that the concerned tree species thrives in northeastern Thailand.

230. In IUCN's entry, Yang Na's geographic range includes Bangladesh; Cambodia; India (Andaman Is., Assam); Myanmar; Philippines; Thailand; Viet Nam. It states," In Indo-China and Thailand the species occurs gregariously along river banks, and in the Philippines, it is found in mixed dipterocarp forest." For Mersawa Kesat, its countries of occurrence are Brunei Darussalam; Cambodia; Indonesia (Jawa, Kalimantan, Sumatera); Malaysia (Peninsular Malaysia, Sabah, Sarawak); Myanmar; Philippines; Singapore; Thailand; Viet Nam. The major threat cited is that it occurs on premium land for conversion to agriculture but also notes that there is conservation action by having "subpopulations within reserves." However, geographic distribution maps of these tree species are not available in the IUCN Red List web site. Mersawa Kesat (Anisoptera costata) is not a Category A timber under the Forest Act but was found to be included in the IUCN Red List while the reverse is true for teak.

231. Under Thailand's Forest Act (1941), the Yang Na, teak and rosewood are Category A restricted timber. The general restriction requires that permission should be obtained from the Royal Forest Department before they are cleared from the ROW. Tree clearing will be allowed after undergoing through the procedure outlined in paragraph 84 of this IEE and complying with all the relevant requirements of the Forest Act.

232. The design of the NH22 and NH23 road widening was reviewed again by the DOH design team to minimize the number of trees that will be affected. Based on the updated design (July 2017), the number of affected trees along NH22 has been reduced from 1,420 trees to 535 trees because of some road sections where the road and median width was reduced while ensuring compliance with the road safety design standards. At NH23, there are no changes in the number of affected trees because of limitations in the road ROW. Rerouting is not possible because the project will only build on the established road ROW of the Government. The project builds from the approved priority action plan of the Government for road widening based on the Government's master plan for roads that was developed in the 1960s. Table 34 presents the category of the affected trees at the project road sections of NH22 and NH23 based on IUCN classification and the number of affected tree per species.

Table 34: Trees Identified for Clearing within the NH22 and NH23 Right-of-Way

Type of Tree Species	Common Name	IUCN Classification[(a)]	Number of Affected Trees	
			NH22	NH23
Anisoptera costata Korth	Mersawa Kesat, Pengiran Kesat	Endangered	-	27
Dipterocarpus alatus Roxb. Ex G. Don	Yang Na	Endangered	3	273
Dalbergia cochichinensis	Siamese Rosewood	Vulnerable	-	11
Pterocarpus indicus Willd.	Burmese Rosewood, Narra	Vulnerable	-	20
Dipterocarpus intricatus	Yang-krat	Least Concern	5	16
Sindora siamensis Teijsm.	-	Least Concern	-	-
Irvingia malayana	Barking deer's mango, wild almond	Least Concern	6	1
Shorea siamensis Miq.	Light Red Meranti (Red Lauan)	Least Concern	-	8
Shorea Obtuse Wall. Ex blume	-	Least Concern	31	-
Cratoxylum formosum	-	Least concern	-	-
Pterocarpus macrocarpus Kurz.	Padauk	Not assessed for the IUCN Red List	146	-
Melaleuca cajuputi	Cajuput	Not assessed for the IUCN Red List	-	-
Crytolepis buchanani Roem	Ganglong	Not assessed for the IUCN Red List	-	-
Erythrophlejum succirubrum Gagnep	Chad	Not assessed for the IUCN Red List	1	2
Tectona grandis L.	Teak	Not assessed for the IUCN Red List	256	11
Butea monosperma (Lam.) Taub	Bastard teak	-	1	-
Barringtonia fusifomis King.	-	Not assessed for the IUCN Red List	-	-

Type of Tree Species	Common Name	IUCN Classification[(a)]	Number of Affected Trees	
			NH22	NH23
Gmelina arborea	Gmelina	Not assessed for the IUCN Red List	-	-
Xylia xylocarpa	-	Not assessed for the IUCN Red List	18	1
Lagerstroemia duperreana Pierre ex Gagnep	Tagab prukbang	Not assessed for the IUCN Red List	1	-
Eclipta prostrate (L.) L.	False daisy Karisalaankanni	Not assessed for the IUCN Red List	-	-
Peltophorum dasyrachis (Mig.) Kurz	Copper Pod, Yellow Flame	Not assessed for the IUCN Red List	-	22
Cryptolepsis dubia (Burm. F.)	-	Not assessed for the IUCN Red List	-	-
Pterospermum littorale Craib var. litorale	-	Not assessed for the IUCN Red List	-	-
Erythopheleum succirubrum Gagnep.	-	Not assessed for the IUCN Red List	-	-
Trichosanthes cucumerina Linn.	Snake gourd	Not assessed for the IUCN Red List	-	-
Albizia procera Benth.	White siris, suan, thingthon	Not assessed for the IUCN Red List	4	14
Parinari anamense hance	-	Not assessed for the IUCN Red List	4	5
Azadirachta indica A. Juss. Var. Siamensis Valeton	Neem	Not assessed for the IUCN Red List	-	42
Dipterocarpus tuberculatis Roxb.	-	Not assessed for the IUCN Red List	-	2
Lagerstroenmia floribunda Jack	-	Not assessed for the IUCN Red List	-	3
Cissampelos pareira	Velvetleaf	-	-	-
Samanea saman (Jacq) Merr	Raintree	-	26	-
Afzelia xylocarpa (Kurz) Craib. T	-	-	16	-
Acacua auriculiformis	Black wattle	Least concern	7	-
Haldina cordifolia	Haldu wood	-	6	-
Terminalia alata heyne ex Roth	Terminalia alata	-	1	-
Anthocephalus chinensis	Wild cinchona	-	1	-
Caesalpinia sappan L	Sappan tree	-	1	-
Nephelium hypoleucum Kurz	Korlan	-	1	-
TOTAL			535	459

Note: (a) IUCN classification for each species was sourced from the IUCN Red List of Threatened Species. http://www.iucnredlist.org

233. Data from the Royal Forest Department shows that teak, Yang Na, Mersawa Kesat, and rosewood are tree species common in northeastern Thailand based on information disclosed by the Provincial Forest Departments during due diligence as well as information shared by

stakeholders during public consultations. The Royal Forest Department (RFD) reported that Teak and Yang Na became famous as commercial tree species in almost all provinces in Thailand because these species can be grown fast. Teak in Thailand is found extensively in the north and stretches along the western border to the east. It is associated with other species in the mixed deciduous forest (*Sumantakul & Sangkul*).[27] Teak is a tropical hardwood tree species that is used as a boatbuilding material, for exterior construction, veneer, furniture, carving, and other wood projects. Teak is one of the most well-known timbers of the world due to its high timber qualities, market demand, ease of domestication and cultivation.[28] The species is native to the Indian-Burmese floristic region and found naturally in India, Myanmar, Thailand, and Lao (*Kaosa-ard, 1983*). Teak plantations have been established throughout the tropics, within and outside its natural distribution range, covering a wide range of climatic conditions, i.e. from equatorial type to the sub-tropical type.[29] In Thailand, the mean annual volume increment of teak plantations over a wide range of plantation conditions varies from 2 m3/ha/year to >15 m3/ha/year at the half rotation age of 30 – 40 years (FAO, 1956; White, 1991; Keogh, 1994).[30] Teak is the main commercial species of Thailand and is the dominant tree in the mixed deciduous forests of northern Thailand (*FAO*).[31]

234. Yang Na is a medium-sized to fairly large tree of up to 40 meters tall, straight, cylindrical, branchless up to 20 meters, up to 150 cm in diameter. The Yang Na trees are commonly found in and around ricefields.[32] Yang occurs along rivers up to 500m altitude, where it is a rapid colonizer of alluvial soils. It can be found in Thailand, Cambodia, Laos, Myanmar, Vietnam and in the Philippines. (*FAO, 1985*)[33] Mersawa Kesat is found in both NH22 and NH23. It is a large tree of semi-evergreen dipterocarp widespread in lowland area, usually growing on ridges with sandy to clayey soils.[34] Mersawa kesat is suitable for interior finish, ship planking, general construction, wooden tanks, tight cooperage, and veneer and plywood.[35] Both Yang and Mersawa Kesat are common species in semi-evergreen rainforests in southeastern and dry evergreen and dipterocarp forests in northeastern Thailand.[36]

235. The 2013 records of the RFD indicate that there are about 25,098 rai or 4,016 hectares of teak plantations and 734 rai or 117 hectares of land with Yang Na that are grown throughout the 20 provinces in northeastern Thailand.[37] There are also about 2,550 rai or 408 hectares where there is co-crop planting of teak and Yang Na trees.[38] Meetings with the Provincial Forest Departments as well as with stakeholders indicated that tree clearing within the road ROW will not result to a significant reduction in the population of these species as these species are indigenous to the project areas.

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[27] Teak resources in Thailand, Vicien Sumantakul and Suntud Sangkul, www.fao.org

[28] Management of Teak Plantations. Apichart Kaosa-ard. Forest Resources Department, Chang Mai University, Thailand. Food and Agriculture Organization. http://www.fao.org/docrep/005/AC773E/ac773e08.htm

[29] Management of Teak Plantations. Apichart Kaosa-ard. Forest Resources Department, Chang Mai University, Thailand. Food and Agriculture Organization. http://www.fao.org/docrep/005/AC773E/ac773e08.htm

[30] Management of Teak Plantations. Apichart Kaosa-ard. Forest Resources Department, Chang Mai University, Thailand. Food and Agriculture Organization. http://www.fao.org/docrep/005/AC773E/ac773e08.htm

[31] Tropical Forest Resources Assessment Project – Forest Resources of Tropical Asia: Thailand Country Brief, Food and Agriculture Organization of the United Nations. http://www.fao.org/3/a-ad908e/AD908E26.htm

[32] The Thai Biodiesel Tree, greennet.or.th

[33] Trees Commonly Cultivated in Southeast Asia. Food and Agriculture Organization. www.fao.org

[34] www.asianplant.net/dipterocapaceae/Anisoptera_costata.htm

[35] www.uses.plantnet-project.org/Anisoptera_costata_(PROSEA)

[36] Tropical Forest Resources Assessment Project – Forest Resources of Tropical Asia: Thailand Country Brief, Food and Agriculture Organization of the United Nations. http://www.fao.org/3/a-ad908e/AD908E26.htm

[37] Source: The Royal Forest Department Information Center, 2013

[38] Source: The Royal Forest Department Information Center, 2013

236. During the meetings with the Provincial Forest Departments in Nakon Phanom, Sakon Nakon, Roi Et, and Yasothon in April 2017, the Forest Departments confirmed that the Yang Na, teak and Mersawa Kesat trees are common trees in the area. There are also forest plantations which include teak, Yang Na and Mersawa Kesat in the eastern provinces of Thailand. Refer to news articles and other references on forest plantations in Appendix 5.

237. Based on information gathered from the website of the Office of Environmental Protection (ONEP), there are 848.68 square kilometers (sq.km.) of forest plantations in Nakon Phanom; 436.36 sq km in Yasothon; 510.71 sq.km. in Roi Et; and 1,910.90 sq.km in Sakon Nakhon. In the eastern region where teak, Yang Na and Mersawa Kesat species are common, a total of 27,555.54 sq.km of forest plantations still exists as of 2009.[39]

238. In Nakon Phanom, the area of affected trees at NH22 only account to 0.51 sq.km or 0.06% of the province's forest plantations. In Yasothon, the affected trees at NH22 account to 0.88 sq.km. or 0.20% of Yasothon's forest plantation of these restricted trees. In Roi Et, there are 0.77 sq.km. of trees in the road ROW which represents 0.15% of the total number of plantation area in the province. In Sakon Nakhon, the affected trees at NH23 account to 1.53 sq.km or 0.08% of the province's forest plantation. Table 35 presents the data on forest plantations which include Yang Na, Mersawa Kesat and teak species in the different provinces in eastern Thailand and the area of the ROW where tree cutting will occur.

Table 35: Land Areas for Tree Cutting in the ROW and Forest Plantations in Eastern Thailand

Province	Total Land Area (sq.km)	Total Forest Plantation Area (sq.km)	Tree Cutting in ROW of NH22 and NH23 (sq.km)	Percentage (%)
Kalasin	6,946.70	752.36		
Khon Kaen	10,886.00	1,287.36		
Chaiyaphum	12,778.30	3,869.27		
Nakon Phanom	5,512.70	848.68	0.51	0.06%
Nakhon Ratchasima	20,494.00	3,132.55		
Buri Ram	10,322.90	963.34		
Maha Sarakham	5,291.70	332.19		
Mukdahan	4,339.80	1,434.01		
Yasothon	4,161.70	436.36	0.88	0.20%
Roi Et	8,299.40	510.71	0.77	0.15%
Loei	11,424.60	3,926.48		
Si Sa Ket	8,840.00	1,069.42		
Sakon Nakhon	9,604.80	1,910.90	1.53	0.08%
Surin	8,124.10	931.21		
Nong Khai	3,027.00	557.41		
Non Bua Lam Phu	3,859.00	594.02		

[39] http://chm-thai.onep.go.th/chm/ForestBio/Complexes-forest-area-provin.html. Date accessed: July 24, 2017

Province	Total Land Area (sq.km)	Total Forest Plantation Area (sq.km)	Tree Cutting in ROW of NH22 and NH23 (sq.km)	Percentage (%)
Amnat Charoen	3,161.20	575.08		
Udon Thani	11,730.30	1,389.09		
Ubon Ratchathani	15,744.80	3,035.11		
Total		27,555.54	3.69	0.49%

Notes:
(a) Data was taken from http://chm-thai.onep.go.th/chm/ForestBio/Complexes-forest-area-provin.html
(b) Shaded rows represent the provinces traversed by NH22 (Sakon Nakhon and Nakhon Phanom) and NH23 (Roi Et and Yasothon).

239. The stakeholders during the public consultation were also asked about any concerns on the cutting of the trees in the road ROW. The stakeholders declared that they do not have any objection to the cutting of these trees since these are within the ROW and could be replaced and replanted anywhere in the area.

240. As part of the mitigation measures, during detailed design, DOH designed the road upgrade to minimize the number of trees to be cut, such as by reducing the design and width of the median. Clearing of trees will be limited to areas that are only necessary based on the project's detailed design. At the outer portion of the road ROW, landscaping will be undertaken.

241. Mitigation measures to conserve and manage trees are as follows:

a) Minimize tree cutting during detailed design of the road upgrade such as by adjusting the median width to minimize number of trees to be cut.
b) Conduct an inventory of affected trees by the DOH District Offices based on the detailed design. The inventory of affected trees will be submitted to the Provincial Forest Department.
c) Inspection and marking of the affected trees by the Forest Department, PONRE, and Forest Industry Organization in coordination with the DOH District Offices.
d) Ensure that site clearing activities will not proceed until the clearance to cut the affected trees is granted to the Forest Industry Organization by the Royal Forest Department in accordance with the procedures and requirements of the Forest Act.
e) Prepare a tree landscaping plan to reduce visual impacts and enhance the long-term visual character of the project alignment.
f) As part of the EMP and in the bid documents, the contractors will be prohibited from cutting trees for firewood and for use in the project and that only legitimate sources of wood will be utilized.

242. **Animal Crossing.** The communities in the vicinity of NH22 and NH23 raise cows and buffalos. The typical design for NH23 road upgrade applies depressed median for lane divider which will not obstruct crossing of cows and buffalos which move from one side of the road to the other for food and agricultural use. The raised median in some sections, mainly the community areas, may create a physical divider to cattle but this issue should be minimal as those areas are mainly for commercial and residential uses. The NH22, on the other hand, will have a raised median; but the approximately 10-centimeter high raised median will not create a physical barrier to cows and buffalos crossings.

243. The impact of the road upgrade to animal access can be mitigated by provision of animal crossing signs to warn motorists of movement of animals on the road. Also in areas with seasonal streams, cattle herds can be redirected to cross the road by traveling along the creek. An information/education awareness program will be necessary to make sure that the local people and owners of cattle exercise caution when animals are being herded to avoid hazard to road traffic. DOH will provide signs in areas with animal crossing in coordination with the local authorities.

244. **Criteria for Location of Associated Facilities.** The operation of construction camps, borrow areas, quarry sites and batching plants will generate a range of environmental and social impacts. The potential effects of borrow areas, quarry sites and batching plants are related to raw materials transport, slope instability, haphazard extraction, and borrow pit abandonment and impacts on public health and safety including noise, dust, and proliferation of mosquitoes causing vector diseases. Quarrying can have long term and permanent adverse impacts such as visual impairment (scarring), change in topography, consumption of resources, change in land use, increased susceptibility to erosion and siltation, and alteration of natural drainage patterns.

245. The direct impacts of borrow pits is clearance of vegetation, loss of soil/resources and change in landform with indirect impacts of visual impairment, increased risk of erosion and siltation, threats to public safety, health hazards as accumulated water can serve as a breeding ground for insect vectors.

246. There is also possible chance discovery of archaeologically significant items or sites during excavation of quarries and borrow pits.

247. Construction camps also generate solid wastes and domestic sewage which needs to be managed properly to avoid problems on health and sanitation and contamination of waterways and existing groundwater supplies.

248. At this stage, the construction camps, borrow areas, and quarry sites have not been determined yet. These areas will be identified by the contractors as part of the construction plan and methods.

249. Contractors' environmental management plan (CEMP) will be required from the civil works contractors to specifically address any identified impacts of construction camps, off-site borrow pit, quarry, and asphalt or concrete batching locations. The contractor will be required to include in the CEMP a material balance estimate for the cut and fill material requirements and identify sources of fill materials. Only authorized or permitted borrow pits and quarries should be used as sources of these materials. If a new quarry will be needed to meet the fill requirements of the project, the contractor should present a quarry development plan together with the CEMP as well as the mining/quarry permit in compliance with Government regulations. If the contractor decides to operate its own aggregate plant, reopening of abandoned quarry sites should be preferred over opening of new quarry site.

250. As a general rule, these facilities should not be located near waterways and drainage canals and should be at least 500 meters away from sensitive areas (i.e. residential communities, hospitals/health institutions, and schools).

2. Construction Environmental Management Plan (CEMP)

251. The EMP will be updated based on the detailed design of the project. The EMP, including the monitoring program will be included in the bid documents to ensure implementation of the mitigation measures to address adverse environmental impacts. The EMP will include a clause requiring each contractor to prepare a contractors' environmental management plan (CEMP) based on the project EMP but with more detailed and specific information on the particular section that the contractor will be working on. This includes the location of the associated project facilities such as construction camp, batching plant, quarry and borrow areas, disposal sites, sensitive receptors in the work area, and the landscaping and replanting activities.

D. Environmental Impacts and Mitigation Measures During Construction

252. Most of the anticipated impacts during construction are minor and short-term which can be managed by adopting appropriate mitigation measures. These include soil erosion which may affect adjacent agricultural land, drainage canals, irrigation channels, and waterways; traffic congestion and accidents; temporary restriction of access; nuisance from noise and vibration; release of dust and engine gas emissions; discharge of wastewater from construction camps; and community and occupational health and safety risks. Recommendations formulated in the EMP, its inclusion in the contractual framework, and an effective inspection of construction sites will reduce these risks to an acceptable level.

253. Construction activities of the proposed project are expected to generate the following adverse impacts:

(a) Cutting of trees
(b) Airborne dust will be caused by excavation, vehicle movement and materials handling at the construction sites.
(c) Noise and air emissions will be caused by construction equipment and vehicular movement, potentially affecting residents of nearby communities
(d) Waste from construction camps includes domestic wastewater and solid wastes.
(e) Traffic congestion will be caused by road construction and increased construction traffic in settlement areas. Roads may be fully or partially closed during construction, causing temporary inconvenience to residents, commercial operations, and institutions.
(f) Generation of excavated materials
(g) Community hazards due to construction activities
(h) Hazards to occupational health and safety.
(i) Interruption of community services. The construction of project facilities may require relocation of utilities such as drainage and prevent access to establishments.

254. In general, the short-term construction impacts can be prevented or mitigated with good construction management practices. The Environmental Health and Safety Guidelines of the World Bank Group (2007) outlines some of the mitigation measures during construction to prevent or minimize construction impacts such as those related to elevated dust, noise, traffic disruptions, erosion and sedimentation, and public and worker safety.

1. Cutting of Trees within the Right-of-Way

255. As mentioned in the pre-construction impacts, trees within the ROW will be removed to make way for the widening of the road. After efforts are made to minimize cutting of trees through adjustments in the design, survey of affected trees will be submitted to the Provincial Forest

Department. The DOH will comply with the requirements of the Forest Act to ensure that cutting of restricted trees are approved by the Royal Forest Department and that trees that could be saved or earthballed and replanted to other areas are identified. Seedlings of the affected trees are readily available from the Provincial Forest Departments and private sellers.

256. During IEE preparation, the DOH has identified and counted the affected trees in the ROW based on the project alignment and the list was submitted to the Provincial Forest Departments. The DOH District Offices have informed the Provincial Forest Departments about the proposed project and submitted the tree inventory. This is the initial step needed to determine which tree cannot be cut and if there is a need for DOH to modify the project design. No tree was initially identified for conservation. Initial assessment indicates that there is no mother tree included in the list. However, the detailed tree inventory by the Provincial Forest Departments is still to be completed and their recommendations will be adopted. The detailed information on the affected trees including the average age, circumference, and height of the affected trees, as well as the presence of mother trees will be determined during the detailed tree inventory that will be conducted by the Provincial Forest Departments' staff who are more knowledgeable on this matter. The tree cutting permit will be issued by the Royal Forest Department (national office) that oversees the Provincial Forest Department and this may take time.

257. It is indicated that any significant changes in the project design would require updating the IEE and the EMP. The EMP also states that site clearing activities, including tree cutting will not proceed until clearance to cut the affected trees is granted. Appendix 5 and the news articles show that conservation efforts for the concerned tree species are in place, that there are forest plantations and replanting programs of teak and Yang Na in Thailand (particularly in the northeastern provinces which is the project site) and there will be no significant loss in the number of these species resulting from the project.

258. Precautions on Tree Cutting. The Forest Industry Organization (FIO), a state-owned enterprise, is the entity authorized by the Government to cut trees that are approved for removal by the Royal Forest Department. Once clearance has been secured for the cutting of trees, the FIO will undertake the tree removal process in close coordination with the DOH District Offices. Detailed procedure to be observed during tree cutting will be stipulated in the CEMP to reflect the specific locations where trees will be felled based on the approved tree cutting clearance. Extra caution will be exercised during the tree removal activity to avoid damage to structures (houses, shops, fences, etc.) that are adjacent to where the trees will be felled as well as avoid any occupational and community hazard.

259. The tree cutting process for large trees will involve cutting of a low cut in the trunk and parallel to the ground. This will be done after the height, diameter and number of segments in the tree have been determined. A large tree may be felled against its natural lean by inserting one or more wedges in the back cut. As the back cut is sawn, the wedges are driven in with an axe (refer to Figure 28).[40] DOH District Office representatives and the environment specialist of CSC will be present during the tree removal activity within the road ROW and the process will be documented and reported in the SEMR.

[40] Special Techniques for Felling Difficult Trees. Occupational Safety and Health Administration, US Department of Labor. https://www.osha.gov/SLTC/etools/logging/manual/felling/cuts/special_techniques.html

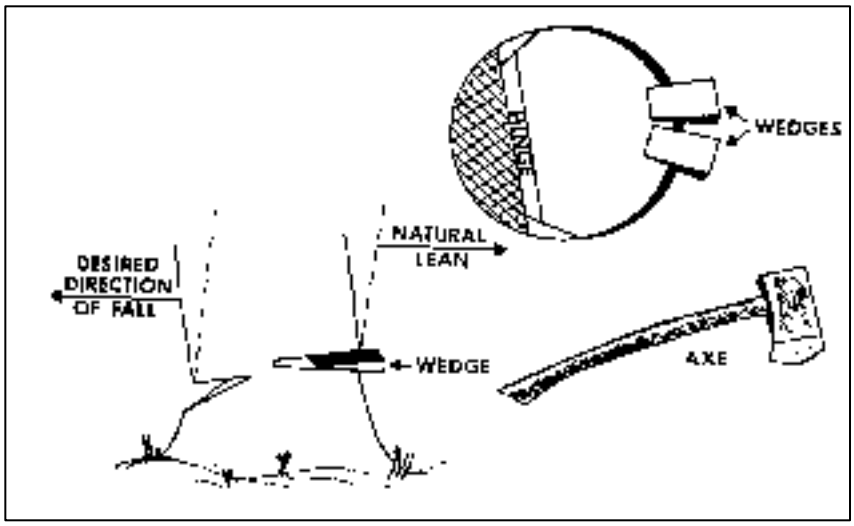

Figure 28: Technique in Wedging Trees
Source: Special Techniques for Felling Difficult Trees.
https://www.osha.gov/SLTC/etools/logging/manual/felling/cuts/special_techniques.html

260. Landscaping. As part of the road widening, the contractor will be required to implement the landscaping and vegetation planting along the roadside alignment in accordance with the highway landscaping plan. The DOH District Office will monitor and assess the condition and effectiveness of project landscaping and replanting as well as implement remedial measures where appropriate by replacing dead or damaged vegetation during the commissioning phase.

261. The DOH will select shrubs and other medium-sized vegetation for landscaping. Large trees can become hazards to errant vehicles and as such can be a safety concern. Based on the DOH Code of Practice on planting on the road ROW, medium-sized perennial plants will be planted at approximately 30 meter spacing, depending on the highway architecture and availability of space. The types of tree species are perennial endemic species that can adapt to the topography and tropical climate of the area. The perennial plants and shrubs must be of the same type for similar growth rate and ease in maintenance. For areas with raised median, the shrubs must not be higher than 0.8 meters to avoid obstructing the line of sight. In addition, the landscaping will be outside of the clear zone[41] to avoid exposure of maintenance workers to vehicle traffic. Under no circumstances shall shrubs, trees or other landscaping materials be placed where it may interfere with highway safety or traffic visibility, including signs and other traffic control devices. In selecting the planting area, the bushes or shrubs should not be planted close enough to the road to avoid root systems from undermining or damaging the road structure. Figure 29 presents a typical landscaping plan of the DOH.

[41] A clear zone is the total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. (Source: AASHTO Roadside Design Guide, 2012)

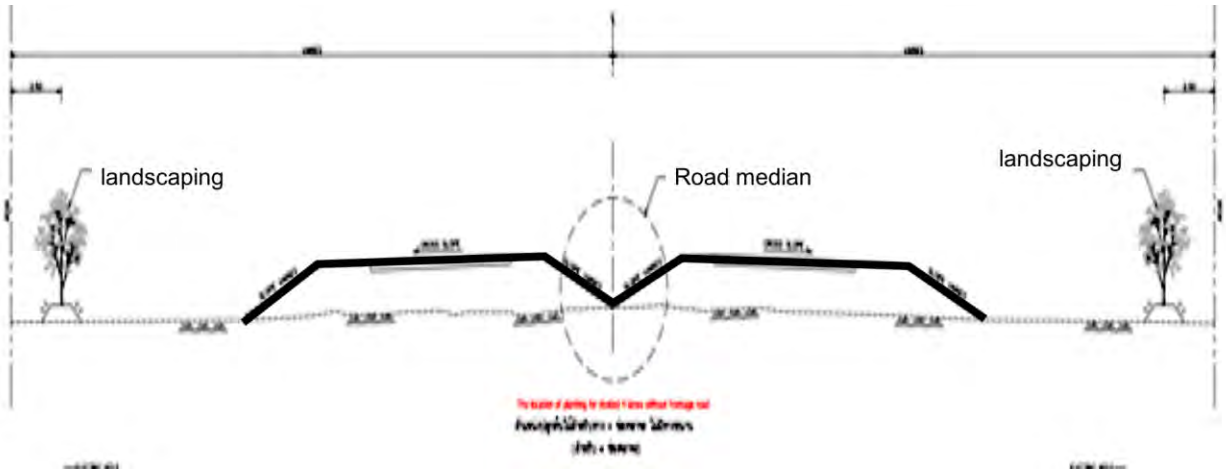

Figure 29: Typical DOH Landscaping Plan

262. The landscaping program will include regular maintenance to ensure that the plant's growth do not obstruct the view of signs or interfere with the sight distances of approaching traffic. Maintenance works include irrigation, removal, relocation, or pruning of plants to eliminate obstruction. The maintenance activities will be undertaken through the DOH District Offices.

263. Replanting. In addition to landscaping along the road, the DOH will also assist the Royal Forest Department in replanting trees, specifically, the Yang Na, teak, and Mersawa Kesat species. There will be approximately 3.69 sq.km or 369 hectares of area with vegetation and trees that will be lost as a consequence of the project. This includes locations where Yang Na, teak and Mersawa Kesat exist as discussed in the previous sections. The replanting program aims to compensate the loss of ecosystem services and damages from tree cutting from the road ROW and to assist in increasing forest cover in the northeastern provinces.

264. The replanting activities will be undertaken in close coordination with the Royal Forest Department, which is the Government organization mandated to implement replanting and reforestation programs. The Royal Forest Department has seed orchards and large nursery centers which could be tapped to provide seedlings. Available land and areas in the provinces traversed by NH22 and NH23 will be surveyed and identified by DOH and the Provincial Forest Departments with assistance of the ADB at the start of construction activities. Areas to be considered are open land of sensitive receptor sites such as schools and temples, recreational parks and other Government land in provinces traversed by the project roads. Consultations with the schools, temples, recreational parks and provincial authorities who will host the replanting site will be conducted together with the Provincial Forest Departments who will provide technical support to DOH and the host communities on the replanting program. Tree replanting will start at the same time as the start of the construction period, with due consideration to replanting in the appropriate season to increase seedling survival. The focus of the replanting program will be the endangered species of Yang Na and Mersawa Kesat as well as the Teak which a Category A species in Thailand. A total of 1,289 trees consisting of 699 Yang Na; 534 Teak; and 56 Mersawa Kesat trees will be replanted by the project. The tree replacement will be at a ratio of 1:2 to account for seedling survival. In case of seedling mortality, the contractor will be required to allocate budget for replacement of seedlings and maintenance until the end of the construction period when the seedling survival achieves a more or less stable state. The number of species of trees to be replanted per contract package is presented in Table 36.

Table 36: Proposed Number and Species of Trees to be Replanted per Contract Package

Species	Package I	Package J	Package K	Package L	Package M	Package N	Total
Yang Na	-	-	-	-	366	333	699
Teak	128	128	128	128	22	-	534
Mersawa Kesat	-	-	-	-	-	56	56
Total	**128**	**128**	**128**	**128**	**388**	**389**	**1,289**

Notes:
Package I – Nong Han-Phang Khon (Section 1A)
Package J – Nong Hang – Phang Khon (Section 1B)
Package K – Sakon Nakon – Nakhon Phanom (Section 2A)
Package L – Sakon Nakon – Nakhon Phanom (section 2B)
Package M – Roi Et – Yasothon (Section 1)
Package N – Roi Et – Yasothon (Section 2)

265. The DOH will also support the replanting program of the Royal Forest Department in watershed areas in the provinces of NH22 and NH23 through participation in actual tree planting activities. These watershed replanting activities will form part of the Corporate Social Responsibility (CSR) program of DOH. The replanting areas will preferably be in watershed areas with low population pressure and grazing demand to ensure high survival rates of the tree species. These replanting sites will also be coordinated with the Provincial Governments to ensure that land use plans and possible land use conversion issues are taken into consideration.

2. Temporary Disruption of Services of Community Facilities

266. The road widening may affect existing community facilities such as street lights, power lines, telephone cables, water lines, canals and driveways to properties and agricultural areas. Near community areas, street lighting poles can be found at existing sections of NH22 and NH23. These were provided by the DOH and could be readily removed and reinstalled along the road. The power lines, telephone cables and water lines are on the border of the road ROW. Road construction activities may cause damage to these infrastructures if care and caution is not exercised by the contractors. The canals, driveways to properties and paths to agricultural areas on the side of the existing road may be affected during construction.

267. The following are the mitigation measures to address the impacts on community facilities:

a) Coordinate with the utility companies and local authorities in laying out the utilities lines prior to transfer, if necessary, so that interruption of services will be at the minimum.
b) Require the contractor to replace structures that may be damaged such as canals, driveways, and paths.
c) Inform affected parties in advance if there will be interruption of services.

3. Air quality

268. During the construction stage, the main sources of air pollution are machines, excavation works, and materials transportation. There is expected increase in dust concentration near construction areas, in the range of about 50 meters around the project sites. The digging and excavation of the soil and movement of vehicles within unpaved roads may cause dust pollution particularly during dry and windy conditions. Winds may carry soil particles to nearby areas, including adjacent built-up areas, if no preventive measure is applied.

269. In addition, the increased number of vehicles moving in and around the project could result to an increase of pollutants coming from motor vehicles. This is a concern in community areas within the alignment as well as other sections where receptors are located within the 100m primary impact area. Possible sources of fugitive dust are transport and hauling of construction materials, travel of project vehicles over unpaved roads, and concrete mixing and batching. There is also release of odor during bitumen application and spreading. Odor will be generally confined within the construction area and will not extend to communities. Workers are the ones most likely to be affected by odor from bitumen application and therefore should be provided with appropriate PPEs when exposed to such activity.

270. Aside from residents within the alignment, workers themselves are also exposed to health hazards of fine suspended particulate matter which is an occupational hazard.

271. Dust generation will be short-term and of moderate magnitude. This can be mitigated through the implementation of dust control measures such as water sprinkling of areas prone to dust emission.

272. Best management practices will be adopted during construction to minimize dust and release of combustion emissions from operation of machines. Before the start of site works, the contractor will be required to prepare the CEMP that will include an air emission and dust control plan. The CEMP shall provide details of mitigation measures, specific location and schedule where such measures will be implemented to minimize impacts to sensitive receptors like residential areas, schools, clinics, hospitals, etc. As far as is practical, any stationary emission source such as diesel generators will be located away from sensitive receptors and residents.

273. To control dust emission, excavated soil and stockpiles will be kept moist while transport vehicles will have tarpaulin covers or other suitable cover materials. Covering the construction materials like cement, sand and aggregates while in transit will also prevent the spillage of these materials. To prevent spreading of soil from the construction area onto the in-use road surface, which subsequently causing dust emission, washing of construction vehicles' wheels will be required before exiting the construction areas. Wash areas with sedimentation tank should be provided so that muddy puddles are avoided and sediment-laden wash water is not discharged directly to drainage canals. In addition, construction equipment and vehicles will be well maintained to reduce pollutant emissions. Speed limits on construction vehicles (typically 25 km per hour or less) will also be imposed to minimize dust emission and reduce the risk of traffic accident.

274. To control odor emission during bitumen application and spreading, such activity will be undertaken when there is less people nearby the road. This should not be timed during school arrivals and departures, temple / church services, and market day when there are more pedestrians that would likely pass and be exposed to odor emission.

4. Noise and Vibration

275. Noise and vibration effects arising from the construction of NH22 and NH23 relate to:

a) Site preparation and clearing activities, and specifically with regard to breaking of sections of existing road surfaces.
b) Construction operations including the movement and operation of mobile or stationary. construction plant equipment, and specifically with regard to ground compaction activities.

276. Based on the results of the baseline noise measurements at NH22 and NH23, the existing noise levels are already exceeding the EHS standards of 55 dBA during daytime and 45 dBA during nighttime. At NH22, the road section in Sakon Nakhon experiences noise levels above the EHS standards as compared to the road section in Nakon Phanom. Sakon Nakon road section and surrounding areas is characterized with community areas located about 50 – 100 meters from the edge of the existing road while the Nakon Phanom section is primarily open agricultural areas.

277. At NH23, the nighttime noise levels exceeded the $L_{Aeq\ 1\text{-}hour}$ in both sampling stations. This may be attributed to the movement of large cargo vehicles during nighttime.

278. In terms of the effects of construction activities during project implementation, the noise impacts of construction to surrounding communities are expected to dissipate with distance from the source. The impacts will be more prominent at the site of the construction activities itself and noise will tend to be less as it moves away from the noise generator.

279. The operation of equipment such as jackhammer, soil compactor, and backhoe during road construction may cause nuisance to activities in nearby temples and residential communities. Along roads used for material transport, the average noise level may rise because of increased truck traffic. Based on the expected noise levels from construction equipment operation, noise levels of 75 dB(A) up to 90 dB(A) may be generated from the operation of construction equipment and vehicles. The affected area could reach approximately 100-meter radius of the construction area.

280. The construction activities would have few fixed or constant construction sites since the concentration of the construction activities would generally move along the highway alignment as the work progresses. Therefore, construction periods longer than one month but less than 4 months is expected along the road widening sections.

281. The following table presents some typical noise levels measured at various distances from operation of construction equipment.

Table 37: Expected Noise Levels from Construction Equipment, dB(A)

Source	Distance from source (m)				
	15	**30**	**60**	**120**	**240**
Front Loader	75	69	63	57	51
Backhoe	85	79	73	67	61
Grader	88	83	78	72	66
Truck	91	85	79	73	67
Concrete Mixer	82	76	70	64	58
Crane	83	77	71	65	59
Generator	78	72	66	60	54
Compressor	81	75	69	63	57
Pump	76	70	64	58	52
Pile Driver	101	95	89	83	77
Jackhammer	88	82	76	70	64

282. During nighttime, construction noise would impose severe nuisance on residents in the vicinity, particularly those located less than 50m from the construction site, thus, the need for managing the noise impact.

283. In terms of vibration, the limit of human perception to vibration is of the order of 0.15mm/s to 0.3 mm/s, in the frequency range of 0.1 Hz to 1500 Hz. The Government of Thailand has no prescribed standard for human perception vibration but has a standard for buildings based on Notification of the Environment Board No. 37 (2010). The vibration standard applicable for Type 3 which includes old buildings was used in the assessment.

284. The measured levels are not significant to induce vibration damage to buildings and structures. However, during construction, vibration is expected to increase due to operation of construction equipment and in particular during pavement breaking and during soil compaction which could induce high dynamic stresses or indirectly high static stresses.

285. The following are proposed noise and vibration mitigation measures during construction:

a) Construction activities, particularly operation of noise generating equipment will be strictly controlled at night particularly in community areas.
b) Position any stationary equipment that produce high noise levels as far as practical from sensitive receptors.
c) If necessary, erect temporary walls or barriers around the construction sites especially near sensitive areas such as schools, hospital, houses, etc.
d) Noise suppression devices will be fitted, when appropriate, to noise generating equipment.
e) Only vehicles and equipment that are registered and have necessary permits will be used for the project.
f) As much as possible, noisy construction activities will be limited to daytime when within 100 meters of a community settlement. Otherwise, prior notification and consultation will be made with affected people and local officials, and suitable noise attenuation measures will be implemented.
g) The contractor will closely coordinate with school administrations on construction schedules to ensure that noise level from the site works are adequately mitigated so as not to be disruptive during school hours.
h) Require drivers to minimize blowing of horn and to comply with the speed limit particularly when passing through residential areas.
i) Provide the community with information on the schedule of noisy construction activities through billboard/signage and complaint hotline.

286. To reduce effects from vibration, mitigation measures to be implemented are as follows:

a) If possible, reroute fully loaded trucks away from roadways that go through heavily built-up areas.
b) Operate heavy equipment away from vibration sensitive areas such as temples and similar old buildings and structures.
c) Avoid simultaneous activities like ground breaking and earthmoving.
d) Avoid use of vibrating rollers near sensitive structures.

5. Erosion and Sedimentation

287. The land clearing and grading operations will result to the exposure of the soil surface to the forces of weathering. The NH22 will have two major river crossings, (i) one crossing over the Chi River and (ii) one crossing over the Yang River. There are also some irrigation canals that may be affected at both NH22 and NH23. Bridge widening works across the Chi River and Yang River at NH23 as well as in other drainage and irrigation canals could result to runoff of sediments into these waterways. During periods of rainfall, sediments may become eroded

and could also cause surface runoff into the adjacent agricultural areas. Dusts and sediments during periods of rainfall may further contribute to overflowing of the drainage system and flooding in the vicinity.

288. In order to prevent the discharge of surface runoff into the canals and waterways and agricultural land, sedimentation ponds and silt traps will be necessary within the construction area to avoid the discharge of silt-laden runoff. As much as possible, construction activities will be timed during the summer months where low precipitation occurs. The mounds of stripped soils should be temporarily covered with impervious materials to minimize erosion and runoff.

289. To prevent serious erosion and sedimentation, the proposed mitigation measures to be implemented are the following:

a) Implement suitable soil erosion control measures e.g. provision of cofferdam and related structures to redirect flows around construction areas, use of silt curtains, silt fences, fiber rolls, etc. These measures will be implemented prior to excavation of the bridge pier foundation and construction activities at waterways to minimize the influx of sediment into surface water.
b) Silted water carried with the spoils during excavation and construction of bridge foundation will be properly treated (e.g. through settling ponds) to prevent sediment-laden water from draining directly back into the waterway.
c) Spoils (excavated soil, rocks, removed asphalt, etc.) shall be transported at DOH reserve areas, making sure that the stockpiles are located away from watercourses and canals and that spoils disposal do not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land, and densely vegetated areas.
d) Avoid or minimize grading during the rainy season to the maximum extent possible, particularly in areas near water courses.
e) Implement phased grading schedule to limit the area subject to erosion at any given time to maximum extent feasible.
f) Use appropriate erosion control and stabilizing measures such as geotextiles, mats, fiber rolls, soil binders, that are not toxic to the environment or vegetation measures/ landscaping in disturbed areas and on graded slopes.
g) Construction works for bridges, culverts and drainage on or near watercourses shall not cause obstruction of channel flow. Slopes along the banks of channels shall be stabilized and dumping of soil, rocks, construction materials and debris onto watercourses shall be prohibited.

6. Flooding

290. The road project is not expected to cause or exacerbate widespread flooding within its corridor. This is partly due to the natural conditions prevailing in the project site. The factors that lessen the possible impacts of the project on flooding is that the natural lines in the project area are in the direction of natural drainage lines. The drainage canals that have reportedly swollen during heavy rain events are due to clogged conditions of canals and due to construction of driveways by establishments. Construction spillage shall not be allowed to be disposed into the canals; the mitigation against erosion and sedimentation will safeguard this issue.

7. Water Quality

291. **Domestic sewage.** Another potential source of water pollution during the construction phase is the generation of domestic sewage from the construction camps. If domestic wastewater

is disposed untreated, the wastewater could lead to the contamination of surface and groundwater and lead to the spread of water-borne diseases. On the average, there will be about 20 – 30 workers in each contract package which generated about 2 – 4 cubic meters per day of sewage. Due to the low magnitude of the wastewater and the provision of wastewater treatment methods, the generation of domestic sewage during construction is not expected to be significant. Appropriate waste management measures will be instituted during the construction phase to prevent adverse effects such as through provision of temporary toilets with septic tanks at construction camps.

292. **Oil spill.** Potential spill and leakage of fuel, petroleum products, lubricants, solvents, and other pollutants related to vehicle and equipment fueling, maintenance, and cleaning may cause serious water pollution. Oil spill could lead to contamination of land. However, volume of oil to be stored and utilized by the project is not expected to be significant, hence, the impact of oil spill is low.

293. The following mitigation measures for reducing such risks are proposed: (i) all vehicles and equipment that regularly enter and leave the construction sites will be fueled off-site; (ii) Vehicle and equipment wash areas will be properly identified by signs and located away from drainage facilities and watercourses. These will be paved with concrete to contain runoff. All vehicles and equipment that regularly enter and leave the construction sites will be cleaned offsite; and (iii) Storage of construction materials will be away from the drainage canal and retention areas will be provided in order to contain accidental spills of such toxic, hazardous, and harmful construction materials as acidic substances, oil and petroleum products, and asphalt materials.

8. Generation of Construction Wastes

294. **Domestic waste.** Solid waste will be generated by construction activities and by workers' camps and canteens. Types of domestic waste from the temporary camps that will be set up for the project needs is estimated to range from 0.4 to 0.5 kg/person/day and would consist of plastic and glass bottles, paper, cardboard, food wastes, and packaging wastes. Appropriate solid waste bins should be provided at the construction camps and work areas.

295. **Inert construction waste.** The inert construction waste during construction consists mainly of wood, scrap, cement bags, aggregates and concrete debris. These wastes are generally disposed of and/or landfilled in appropriate sites and represent no direct danger to health. The scrap metal and wood can be collected for recycling. Materials generated from the breaking of portions of existing road will be brought to existing DOH reserve areas.

296. **Hazardous waste.** Hazardous wastes such as paint containers and solvents and spent batteries are generated by construction activities. Although the quantities are anticipated to be small, this type of waste is harmful to the environment and public health and should be segregated from the ordinary solid waste and collected for appropriate treatment.

9. Temporary Restriction of Access to Properties

297. Construction works in settlement areas may result to temporary disruption to agricultural activities and closure of access. The working area may temporarily alienate access to residential and commercial establishments, schools and community facilities. To mitigate this, the residents must be informed in advance of the approaching construction activities and disruption to those access ways should be limited by providing temporary access to affected properties as soon as

possible. Following completion of construction, good quality permanent access shall be reinstated.

10. Traffic Safety

298. Potential road traffic may occur during the construction of the project. Construction activities may lead to closure of the roads and hamper movement of vehicles and people in the community. NH22 runs across road number 2096, 2225 and 2239. There will be potential inconvenience or closure of portions of these roads during the construction period.

299. In order to avoid causing traffic along the streets, a traffic re-routing scheme will be developed in coordination with the local community. The delivery vehicles will be advised to conduct hauling during off-peak hours where vehicle and pedestrian movement along the street is not significant.

300. Other mitigation measures to avoid inconvenience to the public because of traffic caused by the project construction are:

- Install signages advising the public about future and ongoing construction activities on the affected road, including information about possible traffic rerouting options.
- Employ flag persons to control traffic at sites
- Provide sufficient lighting at night within and in the vicinity of construction sites
- Regularly monitor traffic conditions within the access roads to ensure that project vehicles are not causing congestion.
- As much as possible, schedule the delivery of construction materials and equipment during non-peak hours.

11. Community Health and Safety

301. The community may be exposed to the dangers of construction operations if no mitigation measure is put in place. The presence of population including children next to construction activities will create additional risks to public safety.

302. To prevent accidents and hazards to commuters and passersby during road construction, barricades and steel plate covers will be provided in excavations during non-working time. Warning signs will also be posted in the area.

12. Occupational health and safety

303. During the construction phase, the construction activities could result to hazards on the safety of workers. The contractor will be required to implement a Construction Health and Safety Plan that will include the requirement on wearing of safety gadgets, posting of safety signages, and provision of sufficient lighting at night. The plan should also include the following:

- Identification of measures to manage health and safety hazards associated with construction activities such as working at heights, excavations, use of heavy equipment, and transport of materials.
- Appointment of an environment, health and safety officer to ensure implementation of the Environment, Health and Safety measures
- Provision of first-aid facilities readily accessible by workers

- Provision of adequate housing for workers in construction camps including reliable potable water, sanitation facilities/toilets and bathing areas
- Proper system for the management of solid wastes
- Provision of personnel protection equipment (PPE) for workers
- Posting of safety signs/reminders at the sties
- Provision of sufficient lighting at night.

13. Cultural and Archaeological Sites

304. There are no cultural and archaeological sites within the ROW. However, there are temples within 100 meters from the road which may experience potential impacts from dust and vibration during the construction period. Also, there is potential noise disturbance during religious practice. Although there are no known archaeological sites within the ROW, chance find procedures will be necessary in case an artifact is discovered during the road construction, as well as in quarry and borrow areas.

E. Environmental Impacts During Operation

305. The potential environmental impacts from the operation of the proposed road widening would include increased noise, vibration, air pollution, road accidents due to higher vehicle volume and speed, and soil erosion and flooding due to blocked drainage canals and poor condition of road shoulder. DOH will implement regular maintenance of NH22 and NH23 and will coordinate with the local governments and other concerned agencies to reduce the impacts during the operational phase.

1. Operation Phase Noise

306. Noise during operation of the project depends on the traffic volume, type of pavement, condition of vehicles plying the road, and speed of vehicles. To estimate the impact of the project on the noise levels of the immediate project area, the methodology described by the UK Department of Transport on Calculation of Road Traffic Noise (CRTN) was used in the analysis. The CRTN (1988) is a noise model platform that was introduced and issued by the U.K. Department of Transport (CRTN-ISBN 0 11 550847). The model uses a basic approach for calculating road traffic noise levels for non-complex situations. The model has limitations in terms of calculating any complex arrangements since only road segment noise at assessment points is calculated. The method predicts noise at a reception point from the road and uses parameters such as road surface, traffic flow, speed of traffic, percentage of heavy vehicles/composition of traffic, road gradient, and mean speed. Appendix 6 presents the model inputs and noise calculations for NH22 and NH23.

307. For each road segment, the distance attenuation and screening of the source line or receiver is also taken into account. Instances wherein the view of the road is obscured is taken into consideration. In such case, site observations such as barrier dimensions and height, absorbent ground cover, and average path height are inputted into the model. Examples of barriers that were observed at the project sites are concrete fences, shrubs and trees. If there are reflections from buildings and facades and other site features which may affect noise attenuation, these corrections are also inputted in the model.

308. The existing and predicted traffic flows at three road segments: (i) NH22 in Sakon Nakon, (ii) NH22 in Nakon Phanom, and (iii) NH23 in Roi Et to Yasothon were used to model the noise during operation of the project. The percentage of large vehicles at NH22 is projected to increase

to 13.03% at NH22 in Sakon Nakon; to 11.39% at NH22 in Nakon Phanom; and to 11.89% at NH23 in Roi Et to Yasothon.[42] Considering increased traffic movements on the wider roads, there is anticipated increase of 2.8 dB(A) at NH22 in Sakon Nakon; 5.6 dB(A) at NH22 in Nakon Phanom; and 1.0 dBA at NH23 in Roi Et to Yasothon by year 2040. Primarily as consequence of the increase in projected traffic volume by year 2040 at NH22 in Sakon Nakon-Nakon Phanom section, noise level increase in this segment is high. In addition, the traffic growth in this section is predicted to carry more freight vehicles that produces higher noise levels than light passenger cars.

309. Given the limitations of the model a pragmatic approach is to recommend to the DOH the continuous conduct of noise level monitoring during the operation phase to validate model results and generate actual noise level results. Appropriate measures to mitigate traffic noise may be implemented as necessary should monitoring validate the modeling results in Sakon Nakhon.

310. Despite uncertainties and the limited data available for the model the preliminary results could be used as a management tool and guide the DOH and the local government units to manage noise levels in the future. It could be useful in managing the changes in land use, growth of communities and building of structures along the roads.

Table 38: Predicted Noise Level from Traffic, Leq, dB(A)

Project Road	AADT		Noise level With Project		Increase, dB
	2016	2040	2016	2040	
NH22 (Nakon Phanom)	11864	22288	59.8	62.6	2.8
NH22 (Sakon Nakhon – Nakon Phanom)	6108	22207	59.7	65.3	5.6
NH23 (Roi Et – Yasothon)	14815	18610	64.7	65.7	1.0

Notes: AADT – Annual average daily traffic
AADT and traffic growth rates were based on the Economic Analysis of GMS Highway Expansion Project, prepared by Sudhi, 2017

311. At current condition, sensitive receptors such as residential houses, schools, hospitals, and temples are located with enough distance from the road ROW, thus, noise produced by vehicles are within tolerable hearing range as shown in the noise baseline sampling conducted in April 2017. In the future, residential communities and other noise sensitive receptors/structures may start to build along and near the road ROW. If noise monitoring reveals exceedance of the EHS noise standards, then noise barriers may be considered to minimize noise nuisance to sensitive receptors. Speed limits will continue to be enforced at both highways, and if necessary, speed bumps will be installed at sensitive receptor areas.

[42] AADT and traffic growth rates were based on the Economic Analysis of GMS Highway Expansion Project, prepared by Sudhi, 2017

2. Road Accidents

312. The expansion of the traffic lanes at NH22 in Nong Han to Phang Kon would allow faster traffic which is a potential cause of serious accidents particularly at the road intersections at road number 2096, 2225, and 2239 and in front of schools. The road intersections in Sakon Nakhon to Nakon Phanom with road numbers 2132, 2018, and 2276 are also particularly important in terms of monitoring road accidents. NH23 has a road intersection with road number 202. With wider roads and anticipated more vehicle traffic, there will also be hazards to school children crossing the road. There is also risk of accidents with cows/buffalos crossing the road in areas with grazing or agricultural land uses.

313. Road infrastructures such as pedestrian overpass in front of schools, clear warning signs and traffic signals will be needed to minimize road accidents. Traffic control staff may be necessary at certain times.

3. Greenhouse Gas Emissions

314. The project economic analysis calculated carbon emissions from 2022 to 2040 that will be contributed by the improvements of sections of NH22 and NH23 using the UK Transport Carbon Model (UKTCM). The emissions model of UKTCM is a highly disaggregated, bottom-up model of transport energy use and life cycle carbon emissions that provides annual projections of transport supply and demand for all passenger and freight modes of transport, and calculates the corresponding energy use, life cycle emissions and environmental impacts on an annual basis. The model inputs include scenarios of socio-economic and political developments, travel demand, and vehicle stock. The socio-economic scenarios use gross domestic production, demographics, income, pre-tax and fuel prices while the policy variables take into consideration inputs such as vehicle taxes, speed limits, and driver behavior.

315. The carbon emission rates were calculated using the 2022 traffic data in NH22 (Nong Han – Phang Kon and Sakon Nakhon – Nakon Phanom) and at NH23 (Roi Et – Yasothon) and the traffic growth rate based the northeast gross regional product (GRP) growth rate and income elasticity indicators which was used in the economic analysis of the project (Sudhi, 2017). The load according to vehicle type was assumed in terms of persons/ton taken from the economic analysis of Sudhi.

316. The calculated annual CO_2 emission without the project is 347,365 tons in 2022 which will increase to 453,700 tons by 2040. Primarily due to increase in traffic volume, the annual CO_2 emissions with the proposed project scenario will increase to 364,856 tons in 2022 and to 475,428 tons in 2040. For the road section in Sakon Nakhon to Nakon Phanom, there is no net CO_2 emission increase because the traffic is expected to grow at the same rate with and without project scenarios.

Table 39: Annual Carbon Dioxide Emission from Motor Vehicles Travelling on the Project Roads (tonnes CO_2)

Project Road	Without Project		With Project		Net Emission Increase	
	2022	2040	2022	2040	2022	2040
NH22 (Nong Han – Phang Kon)	94,565	135,062	103,546	147,889	8,980	12,826

Project Road	Without Project		With Project		Net Emission Increase	
	2022	**2040**	**2022**	**2040**	**2022**	**2040**
NH22 (Sakon Nakhon – Nakon Phanom)	82,589	140,602	82,589	140,602	0	0
NH23 (Roi Et – Yasothon)	170,211	178,036	178,722	186,938	8,511	8,902
Total Tonnes CO_2	**347,365**	**453,700**	**364,856**	**475,428**	**17,491**	**21,728**

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

317. An environmental management plan (EMP) has been prepared to provide guidance on how to address identified adverse environmental and social impacts of the project. The EMP outlines the mitigation and monitoring programs to be taken to avoid, reduce, and minimize adverse environmental impacts. The full EMP is presented in Table 40.

318. The mitigation measures are divided into those that will be implemented during the design and pre-construction phase, construction phase, and during the operation and maintenance phase of the project. The EMP matrix also identifies the units that will be in-charge of implementing and monitoring the identified measures. The EMP has been developed based on discussions with DOH, site assessment and from results of the public consultation activities.

319. The EMP as well as the environmental monitoring plan will be included in the bid and contract documents to ensure that the contractors are made aware of these obligations during the construction phase as well as to guide the DOH in supervising and monitoring safeguard performance during construction.

B. Mitigation Plan

320. The following table presents the environmental mitigation measures to be implemented to address potential adverse impacts of the proposed project. The project EMP may require updating to address unanticipated impacts not included in the table. The EMP will be distributed to potential contractors so that the noted mitigation and monitoring requirements can be evaluated and included in the specifications and cost proposals submitted for the proposed project.

321. Inasmuch as some of the associated project facilities such as borrow pits, quarry sites, construction camps, and batching plants will be identified by the contractors, contractors' environmental management plan (CEMPs) will be prepared by the contractors for these facilities to identify potential impacts and the required remedial measures to address these environmental issues. The Construction Supervision Consultant (CSC) will ensure that the CEMPs are in accordance with the EMP requirements before they are submitted for approval to PMU and to ADB. CEMPs should be cleared before civil works commence. The associated project facilities will also be subject to inspection by PMU and CSC to confirm that locations are appropriate and will not cause significant environmental and social issues.

Table 40: Environmental Management Plan

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
A. PRE-CONSTRUCTION PHASE				
1. All environmental impacts identified in the IEE.	1.1 Each contractor will prepare a contractor's environmental management plan (CEMP) which will be submitted for approval to PMU, CSC and ADB prior to start of construction. The project EMP included in the bid documents will be the basis for the CEMP which includes a monitoring program	Contractor	CSC and PMU	Cost to be included in the construction contract
Impacts due to location				
2. Impacts on shops, driveways, and agricultural land within the ROW	2.1 Notify the farmers about the scheduled works. Allow rice farmers within the ROW to plant, before the start of the construction activities.	PMU		No cost anticipated
	2.2 Notify shops and other affected establishments encroaching on the ROW prior to start of construction activities.	Contractor	CSC and PMU	Part of construction cost
3. Trees within the ROW will be removed	3.1 Final design to minimize the number of trees for cutting	DOH Design Group in coordination with DOH District Offices	PMU	Cost included in the design
	3.2 Comply with the provisions of the Forest Act and submit the inventory of affected trees to the Provincial Forest Department which includes information on the number, species, location, and quantities of trees proposed for removal or request for tree inventory survey to the District Chief and Governor.	DOH District Offices	PMU	Cost included in DOH District Offices budget

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	3.3 Coordinate with the Provincial Forest Department, Provincial Office of Natural Resources and Environment (PONRE), and Forest Industry Organization on the detailed inventory of trees, inspection, assessment and tagging of affected trees in line with the procedure of securing the clearance to cut trees to be issued to the Forest Industry Organization, prior to start of project implementation.	DOH District Offices in coordination with Provincial Forest Departments of Sakon Nakon, Nakhon Phanom, Roi Et, and Yasothon, PONRE, and FIO	PMU	Cost included in DOH District Offices budget
	3.4 Ensure that site clearing activities will not proceed until the clearance to cut the affected trees is granted to the Forest Industry Organization.	CSC	PMU	Included in CSC contract cost
	3.5 Conduct inspection and identification of tree replanting sites prior to start of project implementation	DOH District Offices, in coordination with Provincial Forest Departments of Sakon Nakhon, Nakhon Phanom, Roi Et, and Yasothon	PMU	Included in CSC contract cost
	3.6 Prepare a landscaping plan to reduce visual impacts of removing existing trees and to enhance the long-term visual character of the project alignment corridor. The plan will include quantities, varieties and locations of trees and other vegetation.	DOH Design Group, in coordination with DOH District Offices	PMU	Cost included in the design. Seedlings are available for free from the Forest Department and could also be bought from private tree seedling

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
				investors. Estimated cost for teak, Yang Na and Mersawa Kesat is about Baht 300 per seedling.
	3.7 Tree replanting shall be at a ratio of 1:2 for Mersawa Kesat, Teak, and Yang Na. Open areas in temples, schools, recreational parks and other Government land in the provinces traversed by the projects roads will be surveyed and consultations with the schools, temples, recreational parks and provincial authorities who will host the replanting sites will be held in coordination with the Provincial Forest Department who will provide technical support to DOH and the host communities on the replanting program.	Contractor	CSC and DOH District Offices	Package I – $2,400 Package J - $2,400 Package K - $2,400 Package L - $2,400 Package M - $7,050 Package N - $7,100
	3.8 Signing of MOU between DOH and Provincial Forest Departments on replanting program, including 2 years maintenance program	DOH District Offices, CSC, and contractor, in coordination with Provincial Forest Departments of Sakon Nakhon, Nakhon Phanom, Roi Et, and Yasothon	PMU	Included in contractor budget
4. Potential hazards to road safety due to cows/buffalos crossing the highway.	4.1 Determine areas where animal crossing structures/measures such as depressed median, painted median or	DOH Design Group, in coordination with	PMU	Cost included in the design

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	passage under bridges are appropriate for animal access.	DOH District Offices		
	4.2 Conduct an information/education awareness program for local people and owners of cattle and buffalos on safe herding of animals to avoid hazards to road traffic, in coordination with the local authorities.	DOH District Offices	PMU	Cost included in the budget of DOH District Offices
Community Health and Safety				
5. Hazards to community safety due to widened highway	5.1 Identify areas with sensitive receptors.	DOH District Offices	PMU	Cost included in the budget of DOH District Offices
	5.2 CEMP in each contract package should include plan for mitigation of noise, dust, emissions, and traffic safety during construction particularly in work areas near sensitive receptors.	Contractor	CSC and PMU	Included in construction cost
	5.3 Integrate into the project design road infrastructures such as pedestrian overpass, U-turn, traffic lights at appropriate intersections, traffic signs, and roadway lighting.	DOH Design Group in coordination with DOH District Offices	PMU	Cost included in the design
	5.4 Designate areas for bus stops.	DOH Design Group in coordination with DOH District Offices	PMU	Cost included in the design
	5.5 Consult with the community on the locations of the road infrastructures particularly the pedestrian overpass and U-turn.	DOH District Offices	PMU	Cost included in the budget of DOH District Offices
Associated Project Facilities				
6. Borrow areas, quarries and batching plants may cause	6.1 CEMPs will identify the locations of associated project facilities and include	Contractor	CSC and PMU	Cost to be included in

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
adverse environmental impacts related to raw materials transport, slope instability, haphazard extraction, and borrow pit abandonment, possible chance discovery of archaeological artifacts, and impacts on public health and safety including noise, dust, and proliferation of mosquitoes.	mitigation measures for adverse environmental impacts. CEMPs will be reviewed by the CSC, the PMU and ADB prior to start of construction works.			construction contract
	6.2 Identify areas for borrow pits and quarries that are approved by Government and require contractor to present the Government approvals on the borrow pits and quarries prior to start of construction activities.	Contractor	CSC and PMU	Cost to be included in construction contract
	6.3 Quarries, borrow pits and batching plants should not be located in designated national parks or protected areas.	Contractor	CSC and PMU	Cost to be included in construction contract
	6.4 There shall be no quarrying or borrow pit excavation in protected areas.	Contractor	CSC and PMU	Cost included in construction contract
	6.5 Associated project facilities are not located near waterways and drainage canals and human settlement areas and are at least 500 m away from sensitive receptors,	Contractor	CSC and PMU	Cost to be included in construction contract
	6.6 Sites of associated project facilities exclusively created and used for the project should be rehabilitated upon completion of works.	Contractor	CSC and PMU	Cost to be included in construction contract
7. Construction camps and materials storage areas generate solid wastes, domestic sewage, and hazardous wastes which may lead to health and sanitation	7.1 Locate construction camps away from waterways and drainage canals and human settlement areas. The camps should be at least 500 m away from waterways and sensitive receptors.	Contractor	CSC and PMU	Cost to be included in construction contract

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
issues and potential contamination of waterways and existing groundwater supplies.	7.2 Provide adequate and clean housing and sanitation facilities for all workers at the construction camps, including adequate drainage system. All wastewater from construction camps will be treated consistent with national regulations before they are disposed of.	Contractor	CSC and PMU	Cost to be included in construction contract
	7.3 Provide a collection and disposal system for solid wastes within the construction camps.	Contractor	CSC and PMU	Cost to be included in construction contract
	7.4 Provide reliable supply of water for drinking, cooking and washing at the construction camps.	Contractor	CSC and PMU	Cost to be included in construction contract
	7.5 Conduct training/orientation for workers on environment, health and safety, emergency response, and prevention of HIV/AIDS and other diseases before starting work	Contractor	CSC and PMU	Included in construction cost
B. CONSTRUCTION PHASE				
Flora and Fauna				
8. Cutting of trees within the ROW and impacts of site clearing activities	8.1 Clearing of trees will be limited to areas that are only necessary based on the project design.	Contractor	CSC and PMU	Included in construction cost
	8.2 Cutting of trees for firewood and for use in project is prohibited. Only legitimate sources of wood will be used for the project.	Contractor	CSC and PMU	Included in construction cost
	8.3 Tree cutting is carried out in accordance with the Forest Act and permits are secured.	PMU CSC FIO	Forest Department	Included in construction cost
	8.4 Coordinate with the Forest Department on planting activities at the	Contractors	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	outer portions of the ROW as part of the landscaping plan to reduce visual impacts and enhance the long-term visual character of the project alignment.			
	8.5 Conduct tree replanting in DOH reserve areas and other locations agreed with the Forest Department. New alien plant species and invasive species will not be introduced.	DOH District Offices	CSC and PMU	Tree seedlings are given for free by the Forest Department.
	8.6 Tree replanting and maintenance program for 2 years	Contractor, in coordination with DOH District Offices, CSC, and Provincial Forest Departments	PMU	Package I – $2,400 Package J - $2,400 Package K - $2,400 Package L - $2,400 Package M - $7,050 Package N - $7,100
9. Restricted passage and construction hazards to farm animals	9.1 Work areas should be enclosed with fences and temporary animal crossings should be provided. Workers should guide and assist the animal owners when necessary.	Contactor	CSC and PMU	Included in the construction cost.
10. Bridge works may result to adverse impacts to aquatic resources	10.1 Schedule bridge works in the dry season	Contractor	CSC and PMU	Included in the construction cost
Impact on Community Utilities				
11. Road widening may affect existing community facilities such as street lights, power line, telephone cables, water lines,	11.1 Coordinate with the utility companies and local authorities so that interruption of services will be at the minimum.	Contractor	CSC and PMU	To be included in construction contract

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
canals and driveways to properties and agricultural areas.	11.2 Replace damaged community structures.	Contractor	CSC and PMU	
	11.3 Local access roads used by the project are repaired and fully restored at the end of construction of the project	Contractor	CSC and PMU	
	11.4 Notify affected parties in advance if there will be interruption of services.	Contractor, in coordination with the utility companies	CSC and PMU	
Air Quality				
12. Generation of dust and vehicle/equipment emissions that may cause health concerns to roadside communities.	12.1 Regular watering in areas of active construction operations particularly in unpaved areas. Increase frequency of water spraying during dry and windy conditions.	Contractor	CSC and PMU	To be included in construction cost
	12.2 Storage areas of construction materials such as sand, gravel, cement, etc. should be away from sensitive receptors and provided with cover/dust barriers, as necessary.	Contractor	CSC and PMU	To be included in construction cost
	12.3 Conduct daily cleaning of construction areas to remove excess sand, soil, cement, gravel.	Contractor	CSC and PMU	To be included in construction cost
	12.4 Restrict vehicle and equipment speeds to appropriate levels (typically 25 km per hour or less).	Contractor	CSC and PMU	To be included in construction cost
	12.5 Maintain vehicles and equipment in good condition. All construction vehicles and equipment should be tested for compliance with relevant emission standards and properly licensed.	Contractor	CSC and PMU	Included in the construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	12.6 Cover materials during transport with properly fitting tarps.	Contractor	CSC and PMU	To be included in construction cost
	12.7 Install wind fences in applicable areas (e.g., 1- to 2-meter high barriers with 50 percent or less porosity in areas adjacent to sensitive receptors).	Contractor	CSC and PMU	To be included in construction cost
	12.8 Regular inspection and maintenance of construction vehicles and equipment to maximize engine efficiency and reduce emission generation.	Contractor	CSC and PMU	To be included in construction cost
	12.9 Reduce transport distances for material deliveries and other construction-related trips to the maximum extent feasible (e.g., by using local material and labor sources).	Contractor	CSC and PMU	To be included in construction cost
	12.10 Avoid unnecessary and prolonged engine idling or stationary vehicle/equipment operations.	Contractor	CSC and PMU	To be included in construction cost
	12.11 Implementing ride-sharing and shuttle programs for construction workers.	Contractor	CSC and PMU	To be included in construction cost
	12.12 Post contact information (e.g., signs with telephone numbers) and/or maintaining a local office to allow local residents, business operators or other affected individuals an opportunity to report dust- or emission-related issues.	Contractor	CSC and PMU	To be included in construction cost
13. Exposure of people to odor during bitumen application/spreading	13.1 Schedule the bitumen spreading activity at times when there is less people on the road, such as at night.	Contractor	CSC and PMU	To be included in construction cost
Noise and Vibration				

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	14.1 Notify the affected sensitive receptors along the sections where construction will occur prior to start of construction activities.	Contractor	CSC and PMU	To be included in construction cost
	14.2 Avoid simultaneous activities like ground breaking and earthmoving..	Contractor	CSC and PMU	Included in construction cost
	14.3 Provide mufflers for vehicles and equipment to meet noise standard and have these maintained and checked at least every 6 months	Contractor	CSC and PMU	Included in construction cost
	14.4 Locate stationary equipment that produce high noise level as far as practical from sensitive receptors	Contractor	CSC and PMU	Included in construction cost
	14.5 Operation of heavy equipment such as soil compactors should be away from vibration-sensitive areas such as near old temples and sensitive receptors.	Contractor	CSC and PMU	Included in construction cost
	14.6 Provide noise suppression devices, when appropriate, to noise generating equipment.	Contractor	CSC and PMU	Included in construction cost
	14.7 Noisy construction activities will be limited to daytime when within 100 meters of a community settlement. Operation of noise generating equipment will be strictly controlled at night in community areas. Prior notification and consultation will be made with affected people and local officials, and suitable noise attenuation measures will be implemented.	Contractor	CSC and PMU	Included in construction cost
	14.8 Limit noisy activities near schools, particularly during examination period. Contractors will coordinate with school	Contractor	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	administrators on construction schedules.			
	14.9 Only vehicles and equipment that are registered and have necessary permits will be used for the project	Contractor	CSC and PMU	Included in construction cost
	14.10 Require drivers to minimize blowing of horn and to comply with speed limit, particularly when passing through residential areas.	Contractor	CSC and PMU	Included in construction cost
	14.11 Reroute fully loaded trucks away from roadways that go through heavily built-up areas	Contractor	CSC and PMU	Included in construction cost
	14.12 When necessary, erect temporary walls or barriers around the construction sites particularly near sensitive receptors such as schools, hospitals, and residential areas	Contractor	CSC and PMU	Indicative cost of noise barrier, is (approximately $40-60 per sqm)
	14.13 Avoid use of vibrating rollers near sensitive structures.	Contractor	CSC and PMU	Included in construction cost
Soil Erosion and Sedimentation of Waterways				
15. Erosion of sediments into agricultural land, drainage/irrigation canals and waterways and during road widening of bridges and construction of drainage crossing structures	15.1 Use of suitable soil erosion control measures, e.g. silt traps, sedimentation basins, and non-toxic slope stabilization measures, e.g. geotextiles, mats, fiber rolls, soil binders, to prevent soil erosion. For construction activities at waterways (bridges and other drainage crossing structures, use temporary coffer dams and related facilities to redirect flows around construction areas and to minimize the influx of sediment into surface waters.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
	15.2 Spoils (excavated soil, rocks, removed asphalt, etc.) shall be	Contractor	CSC and PMU	Cost for remedial

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	transported at DOH reserve areas, making sure that the stockpiles are located away from watercourses and canals and that spoils disposal do not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land, and densely vegetated areas.			measures will be integrated into construction contract
	15.3 Restrict grading during the rainy season to the maximum extent feasible, particularly in areas of steep topography and/or adjacent to water courses.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
	15.4 Implement phased grading schedule to limit the area subject to erosion at any given time to maximum extent feasible.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
	15.5 Ensure that construction works for bridges, culverts, and drainage on or near watercourses do not obstruct channel flow. Implement slope stabilization and prohibit dumping of soil, rocks, construction materials and debris onto watercourses.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
Water Quality				
16. Generation of domestic sewage	16.1 Provide temporary toilets with septic tanks at construction camps.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
17. Oil, acidic substances, and asphalt materials	17.1 All vehicles and equipment that regularly enter the construction sites will be fueled off-site.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
	17.2 Vehicle and equipment wash areas will be identified with signs, paved with concrete, and located away from drainage facilities and watercourses.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
	17.3 Storage of construction materials will be away from the drainage canal and retention areas will be provided in order to contain accidental spills of such toxic, hazardous, and harmful construction materials.	Contractor	CSC and PMU	Cost for remedial measures will be integrated into construction contract
Generation of Construction Wastes				
18. Solid wastes and domestic sewage will be generated at construction camps. Improper management of these wastes may lead to unsanitary conditions in the area.	18.1 Provide temporary toilets with septic tanks in construction camps.	Contractor	CSC and PMU	Included in construction cost
	18.2 Provide watertight dumpsters/garbage bins at construction camps and schedule daily garbage collection and disposal to a Government-approved solid waste disposal area.	Contractor	CSC and PMU	Included in construction cost
19. Pavement wastes from breaking of portions of existing road shoulders.	19.1 Pavement materials will be brought to existing DOH reserve areas that are located along existing highways.	Contractor, in coordination with DOH District Offices	CSC and PMU	Cost for remedial measures will be integrated into construction contract

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
20. Cut materials from excavation	20.1 Cut materials will be used to fill low-lying areas. Excess materials will be brought to existing DOH reserve areas.	Contractor, in coordination with DOH District Offices	CSC and PMU	Cost for remedial measures will be integrated into construction contract
21. Discharge/runoff of cement from paving operations may damage roadside agricultural land and lead to clogging of drainage and irrigation canals	21.1 Restrict paving operations during wet weather and use sediment control devices downstream of paving activities.	Contractor	CSC and PMU	Included in construction cost
	21.2 Prohibit the washing of cement mixers at the construction site, particularly near drainage canals and waterways	Contractor	CSC and PMU	Included in construction cost
22. Discharge of contaminants such as fuels, lubricants, solvents, concrete, paint, and other hazardous materials that could contaminate waterways, soil, and groundwater	22.1 Minimize the amount of hazardous materials used and stored on-site, and restrict storage/use locations to areas at least 100 m from storm drains and surface waters.	Contractor	CSC and PMU	Included in construction cost
	22.2 Use mobile fueling/maintenance units for construction equipment whenever feasible to avoid/reduce on-site fuel/lubricant storage.	Contractor	CSC and PMU	Included in construction cost
	22.3 Use berms, ditches, and/or impervious liners (or other applicable methods) in material storage and vehicle/equipment maintenance and fueling areas to provide containment and prevent discharge in the event of a spill.	Contractor	CSC and PMU	Included in construction cost
	22.4 Place warning signs and labels in areas of hazardous material storage. Absorbent and clean-up materials should be readily available in the storage area.	Contractor	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	22.5 Disposal of all waste oil, oily rags, spent oil filters, solvents, and oily containers are through authorized waste handlers and recyclers.	Contractor	CSC and PMU	Included in construction cost
	22.6 Provide training for workers in the proper use, handling and disposal of hazardous materials, as well as appropriate actions to take in the event of a spill.	Contractor	CSC and PMU	Included in construction cost
	22.7 Conduct weekly inspection of the hazardous material storage area	Contractor	CSC and PMU	Included in construction cost
Restriction of Community Access / Community Health and Safety				
23. Restriction of access/driveways to residential, commercial, and institutional sites	23.1 Provide advance notification of proposed construction operations, locations and schedules to local residents, businesses and other applicable parties. Regularly coordinate with affected parties during project construction.	Contractor	CSC and PMU	Included in construction cost
	23.2 Provide safe access to properties and establishments and safe passageways for pedestrians affected by construction works	Contractor	CSC and PMU	Included in construction cost
	23.3 Provide temporary pathways and crossings (e.g., metal plates) over excavated areas or trenches during construction of the side drains. Excavated areas should be immediately backfilled, covered and/or repaved.	Contractor	CSC and PMU	Included in construction cost
	23.4 Schedule construction operations to avoid or minimize conflicts with local uses/activities to the maximum extent feasible. This may include efforts such as rescheduling construction operations	Contractor	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	to accommodate: (1) local school and temple schedules, (2) holidays and peak tourist seasons arriving in temples; and (3) agricultural planting and harvest seasons.			
	23.5 Provide informational boards with contact numbers whereby local residents, business operator, farmers and facility users can report issues related to access restrictions.	Contractor	CSC and PMU	Included in construction cost
Traffic / Community Health and Safety				
24. Potential impacts to traffic movements and community safety during road construction and operation of construction equipment	24.1 Coordinate proposed construction activities, schedules, and traffic management plan in advance with local governments, village authorities, businesses, schools, temples and other parties to increase public awareness and reduce potential conflicts.	Contractor	CSC and PMU	The traffic control measures during road construction will be included in the construction contracts.
	24.2 Post information board with contact numbers at local communities and construction sites, including information on temporary lane closures and traffic rerouting	Contractor	CSC and PMU	
	24.3 Employ trained flaggers to direct traffic movements in areas with lane closures	Contractor	CSC and PMU	
	24.4 Use traffic control and warning devices such as lights, signs, traffic cones, flashing board, bollards, and barricades to alert vehicle and pedestrian traffic of potential hazards including lane closures, equipment use, and excavations.	Contractor	CSC and PMU	

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	24.5 Provide sufficient lighting at night within and in the vicinity of construction sites	Contractor	CSC and PMU	
	24.6 Install appropriate safety barriers in areas such as open excavations, slopes, drainages, etc., to avoid unauthorized or accidental access by the public.	Contractor	CSC and PMU	
	24.7 Material deliveries should avoid peak traffic periods	Contractor	CSC and PMU	
	24.8 Orient drivers on safe driving practices to minimize accidents and prevent spills of materials during transport. Limit construction vehicle speeds to appropriate levels (typically 25 km per hour) to reduce accidents	Contractor	CSC and PMU	
	24.9 Regularly monitor traffic conditions along affected roads.	Contractor	CSC and PMU	
25. Hiring of workers from outside the community might create peace and order and social conflicts with local communities and increased HIV/AIDS risk.	25.1 Preferential hiring of qualified local residents in coordination with village officials.	Contractor	CSC and PMU	Included in construction cost
	25.2 HIV/AIDS awareness program for workers will be implemented			
	25.3 Implement the GRM to manage complaints from the community	Contractor	CSC and PMU	Included in construction cost
Worker Health and Safety				
26. Construction-related activities may cause accidents and safety risks to workers.	26.1 Identify measures to manage health and safety hazards associated with construction activities such as working at heights, excavations, use of equipment, and transport of materials	Contractor	CSC and PMU	Included in construction cost
	26.2 Appoint an environment, health and safety officer to ensure implementation of the EHS measures	Contractor	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	26.3 Provide sturdy fencing and fall protection measures on all excavation areas greater than 2 meters deep.	Contractor	CSC and PMU	Included in construction cost
	26.4 Provide sturdy scaffoldings, access, and guardrails at bridge work sites.	Contractor	CSC and PMU	Included in construction cost
	26.5 Provide personnel protective equipment (PPEs) such as hard hats, gloves, safety boots, goggles, life vests/buoyancy devices (at bridge works), ear protection, breathing masks, etc. Wearing of appropriate PPEs while working onsite will be a mandatory requirement for workers.	Contractor	CSC and PMU	Included in construction cost
	26.6 Safety signs/reminders will be posted in strategic areas within the construction area.	Contractor	CSC and PMU	Included in construction cost
	26.7 Implement a waterway safety and traffic plan as part of the CEMP for construction activities at Chi River and Yang River.	Contractor	CSC and PMU	Included in construction cost
	26.8 Provide first-aid facilities and fire-fighting equipment readily accessible by workers at construction camps.	Contractor	CSC and PMU	Included in construction cost
27. Health and sanitation issues may arise at construction camps.	27.1 Provision of adequate housing for workers in construction camps, with reliable potable water, sanitation facilities/toilets and bathing areas. Sleeping quarters and toilets and bathing areas should be separate for male and female workers.	Contractor	CSC and PMU	Included in construction cost
	27.2 Implement proper system for the management of solid wastes	Contractor	CSC and PMU	Included in construction cost
	27.3 Sufficient lighting will be installed at night.	Contractor	CSC and PMU	Included in construction cost

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
28. Use of child labor and trafficked workers	28.1 Contractor should ensure that child laborers and trafficked workers are not employed	Contractor	CSC and PMU	Included in construction cost
	28.2 HIV/AIDS awareness program for workers will be implemented	Contractor	CSC and PMU	Included in construction cost
Physical Cultural Resources				
29. Chance Discovery of Artifacts	29.1 Orient workers on procedures to employ during chance discovery of artifacts. Any chance find should be reported immediately to proper authorities. Work in the site where the artifact is found should be immediately stopped and will resume only once the relevant authorities have provided clearance.	Contractor	CSC and PMU	Included in construction cost
C. OPERATION/MAINTENANCE PHASE				
Air Quality				
30. Air pollution from increased movement of vehicles along the highways resulting to ambient air quality above the standards	30.1 Coordinate with the Provincial Office and other agencies regarding traffic management and emission tests of vehicles.	Provincial Government	DOH District Offices	Cost to be determined
Noise and Vibration				
31. Increase noise and vibration from movement of vehicles along the highways.	31.1 Monitor noise levels and when necessary, implement noise mitigation measures such as enforcing speed limits, provision of speed bumps or noise barriers in populated areas and other locations where there are sensitive receptors	DOH District Offices		Cost included in regular DOH District Office budget
	31.2 Maintenance of trees planted at the roadsides to serve as noise buffer, particularly in areas with sensitive receptors such as temples, schools, and hospitals.	DOH District Offices		Cost included in regular DOH District Office budget
Community Health and Safety				

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
32. Potential increase in local accident rates due to higher vehicle speeds on the proposed 4-lane roadway.	32.1 Features such as traffic lights at appropriate intersections, traffic signs at appropriate locations and intervals, and roadway lighting have been incorporated into the project design to address public concerns and maximize traffic and pedestrian safety.	DOH District Offices		Cost of mitigation are included in overall project cost
	32.2 Post speed limits along the roads	DOH District Offices		Cost of mitigation are included in overall project cost
	32.3 Increase police patrols/enforcement in problem areas.	Provincial Police		Cost of mitigation are included in overall project cost
	32.4 Provide animal crossing signs to warn road users in areas where there is frequent movement of animals across the road.	DOH District Offices		Cost of mitigation are included in overall project cost
Traffic				
33. Road repair and maintenance work may necessitate the closure or partial closure of the road or diversion of traffic to alternate routes.	33.1 Install warning signs at the approaches of the work site and provide alternate route, if possible. In case of absence of alternate route, there will be temporary closure of one lane of the road until the completion of repair.	DOH District Offices		To be determined by DOH
	33.2 Install barriers in the work area.	DOH District Offices		To be determined by DOH

Environmental Impact	Proposed Mitigation Measures	Responsible Unit		Estimated Cost
		Implementation	Supervision	
	33.3 Require workers to wear PPEs including high visibility vest. Work site should be provided with lighting for nighttime works.	DOH District Offices		To be determined by DOH
	33.4 Notify the public in advance about temporary lane closures and road repair works.	DOH District Offices		To be determined by DOH

C. Monitoring Program

322. The following table presents the proposed environmental monitoring plan of the project:

Table 40: Environmental Monitoring Plan

Parameters	Means of Monitoring	Location	Frequency/ Schedule	Responsibility	Estimated Cost (USD)
A. Pre-Construction Phase					
1. Inventory of affected trees	ROW inspection and tagging of trees based on detailed project plans	ROW of NH22 and NH23	Once	DOH District Offices	Part of operations cost
2. Survey of sensitive receptors and distance from road; assessment of needs for pedestrian overpass, U-turn, bus stops	Inspection of ROW and areas within 100m from ROW based on detailed project plans	ROW and immediate vicinity (~100m from the road) of NH22 and NH23	Once	DOH District Offices	Part of operations cost
3. Water quality - Turbidity - DO - temperature - pH	In-situ sampling using portable analyzer approved by National Environment Board	At bridges with river crossing at Chi River and Yang River (NH23 in Roi Et)	Once before start of construction	CSC	Water quality monitoring will be included in the CSC contract, with no additional costs

Parameters	Means of Monitoring	Location	Frequency/ Schedule	Responsibility	Estimated Cost (USD)
		- 50 m upstream and 50 m downstream of bridges across Chi River and Yang River			to DOH. Portable water quality test equipment to be procured by CSC and turned over to DOH after project.
4. Air Quality - PM2.5 - PM10 - TSP	24-hour continuous sampling using analytical methods approved by NEB	Road sections within 100 m from selected sensitive receptors (schools, hospitals, temples) where there is ongoing construction works	Once before start of construction	CSC	Air quality monitoring will be included in the construction contracts, with no additional costs to DOH. High volume sampler will be procured by CSC and turned over to DOH after project.
5. Noise and Vibration - $L_{Aeq24\ hour}$ - L_{Adn} - L_{Amax} - vibration (frequency and velocity)	Use sound level meter and vibration meter	Road sections within 100 m from selected sensitive receptors (schools, hospitals, temples) where there is ongoing construction works	Once before start of construction	CSC	Noise and vibration monitoring will be included in the CSC contract, with no additional costs to DOH. Sound level meter to be procured by CSC and turned over to DOH after project.

Parameters	Means of Monitoring	Location	Frequency/ Schedule	Responsibility	Estimated Cost (USD)
6. Survey of associated project facilities such as quarries, borrow pits, and batching plants	Field observations Check Government permits of quarries, borrow pits, and batching plants.	Borrow pit sites and quarry sites Batching plants	Before start of construction activities.	CSC and PMU	Part of pre-construction cost.
B. Construction Phase					
7. Water quality - Turbidity - DO - temperature - pH	In-situ sampling using portable analyzer approved by NEB	At bridges with river crossing at Chi River and Yang River (NH23 in Roi Et) - 50 m upstream and 50 m downstream of bridges across Chi River and Yang River	Monthly	CSC	Water quality monitoring will be included in the CSC contract, with no additional costs to DOH. Portable test equipment to be procured by CSC and turned over to DOH after project.
8. Effluent discharge at construction camps - Total Suspended Solids - DO - BOD - oil/grease - coliform - nitrates - phosphates	Collect samples for laboratory analysis using analytical methods approved by NEB	Effluent from construction camps	Every 6 months	CSC	Effluent monitoring will be included in the CSC contract, with no additional costs to DOH. Estimated cost of sampling and laboratory analysis is US$500 per monitoring station.

Parameters	Means of Monitoring	Location	Frequency/ Schedule	Responsibility	Estimated Cost (USD)
9. Air Quality - PM2.5 - PM10 - TSP	24-hour continuous sampling using analytical methods approved by NEB	Road sections within 100 m from selected sensitive receptors (schools, hospitals, temples) where there is ongoing construction works	Every 6 months	CSC	Air quality monitoring will be included in the construction contracts, with no additional costs to DOH. High volume sampler will be procured by CSC and turned over to DOH after project.
10. Noise and Vibration - $L_{Aeq24\ hour}$ - L_{Adn} - L_{Amax} - vibration (frequency and velocity)	Use sound level meter and vibration meter	Road sections within 100 m from selected sensitive receptors (schools, hospitals, temples) where there is ongoing construction works	Every 3 months	CSC	Noise and vibration monitoring will be included in the CSC contract, with no additional costs to DOH. Sound level meter to be procured by CSC and turned over to DOH after project.
11. Waste management - Segregation of biodegradable and non-biodegradable wastes and proper disposal of wastes - Inspection of solid waste along the construction road	Field observation	Construction camps Roadside along the road construction.	Daily inspection	Contractor / CSC / PMU	Part of construction cost

Parameters	Means of Monitoring	Location	Frequency/ Schedule	Responsibility	Estimated Cost (USD)
- Inspection of waste oil and grease and hazardous waste storage area					
12. Check growth/survival of trees planted	Field observation	At landscaped area and tree planting sites	Monthly	Contractor / PMU / CSC	Part of construction cost
C. Operation Phase					
13. Traffic safety - Incidence of traffic accidents and pedestrian injury	Community and police reporting	NH22 and NH23	Semi-annual	DOH District Offices in coordination with police and village leaders	Part of operations cost
14. Noise level	Noise level meter	Areas with sensitive receptors and built-up areas along NH22 and NH23	Monthly and as necessary	DOH District Offices	Part of operations cost

D. Environmental Management and Monitoring Costs

323. The cost for the environmental safeguard activities, i.e. environmental assessment, review, and monitoring, will be primarily borne by the contractor. The inventory of affected trees along the alignment and survey of sensitive receptors based on the final detailed design will be through the operations budget of the DOH District Offices while the tree planting activities will be undertaken by the Provincial Forest Departments, as the Government agency mandated to undertake such works. The indicative cost items per management and monitoring parameter is presented in Table 42.

Table 41: Activities and Indicative Cost for Environmental Management and Monitoring

Activity	Responsibility	Estimated Cost (US$)
a) Survey of trees for removal	c/o DOH District Offices operations cost	
b) Survey of sensitive receptors	c/o DOH District Offices operations cost	
c) Acquisition of environmental monitoring equipment(2)	c/o CSC contract (equipment to be turned over to DOH)	
• Portable water quality test equipment (turbidity, pH, temperature, DO)		4,100
• High volume sampler (for PM_{10}, $PM_{2.5}$ and TSP)		18,200
• Sound level meter (for $L_{Aeq24\ hour}$, L_{Adn} and L_{Amax}) compliant to IEC60942:2003 Class I		3,100
• Vibration meter and Base Unit / BE201191		6,100
• Replenishable items (air filters, reagents, calibration) for two years		1,800
d) Effluent monitoring at construction camps; US$600 per sampling; 5 times for 2 years	c/o CSC contract	3,000
e) Replenishable items (air filters, reagents, calibration)	c/o CSC contract	1,800
f) EMP implementation and monitoring	c/o construction cost	
g) Tree planting and landscaping	c/o contractor in coordination with Provincial Forest Departments and replanting sites	23,350
• Package I		2,300
• Package J		2,300
• Package K		2,300
• Package L		2,300
• Package M		7,050
• Package N		7,100
h) Training of DOH and contractors on environment safeguards and EMP implementation, monitoring, and	c/o CSC contract	2,000

Activity	Responsibility	Estimated Cost (US$)
calibration/use of portable sampling equipment		
i) Community awareness program (continuing consultations)	c/o construction cost	
TOTAL		**61,650**

E. Institutional Arrangements for Environmental Management

324. The implementation of the environmental mitigation and monitoring measures will be the responsibility of the Department of Highways as executing agency of the project. The following section presents the roles and responsibilities of the various units in environmental management.

1. Department of Highways (DOH)

325. The DOH is the Project owner, responsible for project management including overall environmental management. The Environmental Division of DOH is in charge of guiding and supervising implementation of the EMP for this project and associated projects, if any. The other responsibilities of DOH are to:

a) Ensure that sufficient funds are available to properly implement the EMP
b) Ensure that EMP provisions are implemented for the entire
c) Ensure that project implementation complies with the Thai and ADB's environmental policy, principles and requirements indicated in the SPS
d) Update the IEE and EMP as necessary when new information becomes available or changes in project design are made, that would affect EMP
e) Submit semi-annual environmental monitoring reports (SEMR) to ADB following an agreed submission schedule.

2. Project Management Unit (PMU)

326. The PMU of DOH is responsible for the implementation of the Thai Highway Expansion Phase 2 Project. Its responsibilities include:

a) Overall planning, management and monitoring of the environmental management.
b) Ensuring that all environmental protection and mitigation measures of environmental impacts are carried out in accordance with policies regulations on environment and other relevant laws.
c) Organizing training courses for local staff and contractor’s teams on mitigation measures and safety methods.
d) Carrying out internal monitoring and supervising independent monitoring if necessary, which will be contracted with other consulting services of the project.
e) Supervising and providing budget for monitoring activities.
f) Reporting on environmental information to DOH and ADB.
g) Ensure that sufficient funds are available to properly implement the EMP.
h) Ensure that EMP provisions are implemented for the entire project regardless of financing sources.
i) Ensure that project implementation complies with ADB's SPS principles and requirements.

j) Ensure that tender documents and civil works contracts include the Project EMP and monitoring program and specify requirement for preparation and implementation of construction EMP (CEMP)
k) Review and approve the CEMPs with assistance from the Construction Supervision Consultant (CSC).
l) Identify and propose environmental corrective actions based on the results of EMP monitoring and prepare a corrective action plan, as necessary, for submission to ADB.
m) Establish an environmental grievance redress mechanism, in close coordination with CSC that is acceptable to ADB, to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the Project's environmental performance.
n) Submit quarterly environmental monitoring reports to ADB through DOH.

3. Construction Supervision Consultant (CSC)

327. The Construction Supervision Consultant (CSC) is tasked to make sure that construction work proceeds smoothly, including the full implementation of the CEMP. Its specific responsibilities include:

a) Prepare and submit to DOH and ADB technical and financial proposals in their bids for environmental monitoring and other services.
b) Engage environment specialists to undertake regular project monitoring and reporting based on EMP provisions.
c) Prior to implementation of civil works, assist DOH/PMU in reviewing the CEMPs prepared by contractors to ensure that these are consistent with the provisions of the EMP. CSC should guide the contractors in CEMP preparation when necessary.
d) Assist DOH in monitoring the implementation of mitigation measures during preconstruction phase and the environmental performance of contractors based on the EMP and the CEMPs.
e) Incorporate in the SEMRs the results of environmental effects monitoring and undertake data analysis.
f) Assist PMU in preparing SEMRs for timely submission to ADB.
g) Assist DOH/PMU to ensure that the EMP provisions are included in the tender documents and civil works contracts.
h) Assist PMU in establishing the GRM and ensure that it is functioning effectively.

3. Construction Contractors

328. The Construction Contractors will be selected by DOH/PMU. Their responsibilities include satisfactory implementation of construction works and contractor specifications outlined in the EIA and EMP. Contractors are tasked to:

a) Recruit a qualified Environmental Officer on a full-time basis to ensure compliance to environmental contractual obligations and proper implementation of the EMP/CEMP.
b) Prepare and submit to DOH/PMU a CEMP prior to commencement of civil works.
c) Ensure proper implementation of the EMP/CEMP and provide sufficient budget to implement the mitigation measures.
d) Carry out weekly environmental monitoring on the work sites and allied facilities and submit monthly reports to DOH/PMU/CSC on the monitoring results of EMP implementation.
e) Implement additional environmental mitigation measures, as necessary.
f) Apply all mitigation measures suggested in EMP/CEMP during construction of roads and bridges.
g) Ensuring safety of construction workers and local people during construction.

h) Following Thai and ADB policies on environmental protection and biodiversity conservation during construction.

F. Reporting

329. **Construction Phase.** Throughout the construction period, the contractor will submit monthly progress reports to PMU while the CSC through the PMU will submit semi-annual reports to the ADB. The semi-annual reports submitted by the CSC to the PMU will consolidate the reports submitted by the contractor and will highlight a summary of the progress of construction, results of site inspections, progress made in EMP implementation, status of compliance with Government's environmental regulatory requirements and other clearances, record of community complaints, unforeseen environmental impacts and suggested remedial actions for the next monitoring period. Appendix 2 presents a template of the environment safeguard monitoring report.

330. Once the monitoring reports are received by the PMU, these will be reviewed by the CSC relative to project compliance with the indicators defined in the EMP. The PMU will supervise and validate the implementation of the mitigation measures specified in the EMP through site visits and review of EMP implementation reports of the contractor. The PMU will also coordinate environmental monitoring in accordance with the monitoring plan and prepare the semi-annual environmental monitoring reports in English to be submitted to ADB.

331. **Operational Phase.** The EMP monitoring during the operational phase of the project will be undertaken by the DOH District Office, with verification by the PMU who will report to ADB the project's adherence to the EMP, information on project implementation, and environmental compliance through semi-annual environment progress reports. The operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all covenants under the project will also be included in the report.

332. The semi-annual environment progress reports shall be prepared by DOH and submitted to the ADB until a Project Completion Report (PCR) is issued. Within three months after completion of each contract package, environmental acceptance monitoring and audit reports for the completed package will be prepared by the contractor and submitted to the PMU through the CSC.

333. The following presents the reporting plan.

Table 42: EMP Reporting Plan

Type of Report	Basic Content	Prepared by	Submitted to	Frequency
Construction Phase				
Construction progress report	Progress of construction, including EMP monitoring results	Contractors	CSC and PMU	Monthly
Environmental Monitoring Report	EMP implementation, environmental monitoring, compliance with Government environmental requirements, complaints received	PMU through CSC	ADB	Semi-annual

Type of Report	Basic Content	Prepared by	Submitted to	Frequency
	and actions undertaken			
Operational Phase				
Progress report	Project status including section on EMP implementation and monitoring	DOH District Offices	PMU	Semi-annual until project completion report (PCR)
Reports to ADB	Subproject progress report, including section on EMP implementation and monitoring	PMU through CSC	ADB	Semi-annual until PCR

IX. CONCLUSION AND RECOMMENDATIONS

334. The results of the IEE show that the proposed project will not result to significant adverse environmental impacts. Environmental mitigation measures have been designed as outlined in the EMP to address any adverse impacts during the various phases of project implementation. The EMP also presents the institutional responsibilities for implementing the mitigation measures. The IEE concludes that the design of the project combined with available information on affected environments is sufficient to identify the scope of potential environmental impacts of the project. Provided that significant changes to the project component do not occur at the detailed design phase and that new sensitive environmental or cultural resources are not determined, further detailed environmental impact assessment of the project is not required for submission to ADB.

335. In compliance with the requirements on the Forest Act 2484 (1941) and the 1968 law on the cutting of trees within the ROW of national highway, the DOH will report and submit to the Provincial Governor an inventory of trees prior to the start of construction activities. The procedure outlined in the Forest Act will be followed to ensure that cutting of restricted trees is approved by the Royal Forest Department.

336. The EMP will be updated should there be any major changes in the detailed design of the project. The EMP, including the monitoring program will be included in the bid documents to ensure implementation of the mitigation measures to address adverse environmental impacts. The EMP will include a clause requiring each contractor to prepare a contractors' environmental management plan (CEMP) based on the project EMP but with more detailed and specific information on the particular section that the contractor will be working on. This includes the location of the associated project facilities such as construction camp, batching plant, quarry and borrow areas, disposal sites, and sensitive receptors in the work area.

Appendix 1: Rapid Environmental Assessment Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES), for endorsement by Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:	**THAILAND: GREATER MEKONG SUB-REGION HIGHWAY EXPANSION PHASE 2 PROJECT**
Sector Division:	SERD/SETC

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area adjacent to or within any of the following environmentally sensitive areas?			
Cultural heritage site		X	
Protected Area		X	There are no protected areas in the vicinity of the road alignments. The nearest protected area is the Phu Pha Lek National Park which is about 30 km from National Highway 22.
Wetland		X	
Mangrove		X	
Estuarine		X	
Buffer zone of protected area		X	
Special area for protecting biodiversity		X	
Potential Environmental Impacts Will the Project cause…			
▪ encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?		X	

Screening Questions	Yes	No	Remarks
▪ encroachment on precious ecology (e.g. sensitive or protected areas)?		X	
▪ alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?	X		There will be no alteration of hydrology of waterways crossed by roads. However, increased sedimentation in streams and canals during widening of bridges and installation of culverts will be addressed in the EMP.
▪ deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	X		The EMP will require appropriate sanitary facilities with septic tanks in the camps and sediment control measures during road construction particularly during the rainy months.
▪ increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?		X	
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?	X		Contractors will be required to provide construction workers with the appropriate personal protective equipment (PPE) and implement other measures to protect workers.
▪ noise and vibration due to blasting and other civil works?	X		There will be no blasting activities but noise generated during civil works will be mitigated by measures in the EMP.
▪ dislocation or involuntary resettlement of people?		X	
▪ dislocation and compulsory resettlement of people living in right-of-way?		X	
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	
▪ other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress?		X	
▪ hazardous driving conditions where construction interferes with pre-existing roads?	X		Hazardous road conditions may occur during construction hence, appropriate traffic management and safety measures will be included in the EMP.
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?		X	

Screening Questions	Yes	No	Remarks
▪ creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?		X	
▪ accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials?		X	
▪ increased noise and air pollution resulting from traffic volume?	X		Noise and air pollution from increased traffic volume may occur once the project is completed. The EMP will include operation phase monitoring activities so this can be checked.
▪ increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?		X	
▪ social conflicts if workers from other regions or countries are hired?		X	Priority will be given to qualified local workers.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	Hiring of local workers will be prioritized. The contractor will be required to provide adequate water supply and sanitation systems.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		X	
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.	X		Community safety risks will be addressed in the EMP. The project design will include safety features to protect road users and pedestrians.

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: THA: Greater Mekong Sub-region Highway Expansion Phase 2 Project

Sector : Transport

Subsector:

Division/Department: SETC/SERD

Screening Questions		Score	Remarks[43]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	0	The road sections are not considered flood-prone areas and area also not subject to landslides, droughts, and storms.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	0	
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	0	These factors are considered during detailed engineering design.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	0	
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	0	

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response, will be categorized as high risk project.

[43] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

Result of Initial Screening (Low, Medium, High: LOW

Other Comments:_____
_____

Prepared by: _____

Appendix 2: Template of Environment Safeguard Monitoring Report

Outline of Semi-annual Environmental Monitoring Report

The borrower/client is required to prepare monitoring reports every six months that describe progress with implementation of the project EMP and compliance issues and corrective actions. A sample outline which can be adapted as necessary is provided below.

I. Introduction – brief description of project and its components; list each civil work contract package and the scope of work for each, and the starting date of each package
   a. Report Purpose
   b. Project Implementation Progress – physical progress of each package

II. Incorporation of Environmental Requirements into Project Contractual Arrangements - manner by which EMP requirements are incorporated into contractual arrangements, such as with contractors or other parties.

III. Summary of Environmental Mitigations and Compensation Measures Implemented - based on EMP; may include measures related to air quality, water quality, noise quality, pollution prevention, biodiversity and natural resources, health and safety, physical cultural resources, capacity building, and others.

IV. Summary of Environmental Monitoring
   a. Compliance Inspections
   b. Activities Mitigation Compliance
   c. Mitigation Effectiveness

V. Ambient Monitoring Program (if relevant)
   a. Summary of Monitoring
   b. Results
   c. Assessment

VI. Key Environmental Issues
   a. Key Issues Identified
   b. Action Taken
   c. Additional Action Required

VII. Conclusion
   a. Overall Progress of Implementation of Environmental Management Measures
   b. Problems Identified and Actions Recommended

Appendices

A. Site Inspection / Monitoring Reports/ EMP Monitoring Checklist
B. Ambient Monitoring Results (if applicable)
C. Photographs
D. Others

Appendix 3: Photographs of Public Consultation Meetings and Attendance Sheets

Public Consultation for NH22
March 8, 2017
Muang Thai Soe, Kusuman Sub-district, Sakon Nakhon District






Public Consultation for NH22
March 9, 2017
Wong Ta Mua Municipality, Nakon Phanom Province








Public Consultation for NH22
March 7, 2017
Nong Kung Village, Phang Khon Tambun, Phong Khon, Sakon Nakhon






Public Consultation for NH22
March 8, 2017
Sawang Daen Din Sub-district, Sakon Nakhon District








Public Consultation for NH23
March 14, 2017
Non Yang School, Ban Non Yang, Roi Et Province





Public Consultation for NH23
March 14, 2017
Doet Municipality, Yasothon Province






Public Consultation for NH23
March 13, 2017
Ban Niwet, Niwet Subdistrict, Thawat Buri District, Roi Et Province

Public Consultation for NH23
March 14, 2017
Selaphum Municipality, Roi Et Province








Public Consultation for NH23
March 13, 2017
Thawat Buri District, Roi Et Province

Appendix 4: Results of Environmental Quality Monitoring

United Analyst and Engineering Consultant Co., Ltd.
3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

ANALYSIS REPORT

CUSTOMER NAME : ASIAN DEVELOPMENT BANK

ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444

MEASURING PLACE : BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON

MEASURING TYPE : AMBIENT (AIR) **RECEIVED DATE** : APRIL 3-4, 2017

MEASURING DATE : APRIL 3-4, 2017 **ANALYTICAL DATE** : APRIL 3-4, 2017

MEASURING TIME : * **ANALYSIS NO.** : PAF115/2017

MEASURING METHOD : CHEMILUMINESCENCE **WORK NO.** : FMD1622/2017

MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00977/2017

TIME*	RESULT
	NITROGEN DIOXIDE
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON
	APRIL 3-4, 2017
	PAF115/2017
10:00-11:00 HOUR	0.0056
11:00-12:00 HOUR	0.0053
12:00-13:00 HOUR	0.0032
13:00-14:00 HOUR	0.0060
14:00-15:00 HOUR	0.0055
15:00-16:00 HOUR	0.0058
16:00-17:00 HOUR	0.0056
17:00-18:00 HOUR	0.0049
18:00-19:00 HOUR	0.0103
19:00-20:00 HOUR	0.0124
20:00-21:00 HOUR	0.0113
21:00-22:00 HOUR	0.0071
22:00-23:00 HOUR	0.0051
23:00-00:00 HOUR	0.0072
00:00-01:00 HOUR	0.0098
01:00-02:00 HOUR	0.0069
02:00-03:00 HOUR	0.0058
03:00-04:00 HOUR	0.0052
04:00-05:00 HOUR	0.0048
05:00-06:00 HOUR	0.0042
06:00-07:00 HOUR	0.0040
07:00-08:00 HOUR	0.0063
08:00-09:00 HOUR	0.0056
09:00-10:00 HOUR	0.0034
UNIT	ppm

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

United Analyst and Engineering Consultant Co., Ltd.
3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

ANALYSIS REPORT

CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM		
MEASURING TYPE	: AMBIENT (AIR)	**RECEIVED DATE**	: APRIL 3-4, 2017
MEASURING DATE	: APRIL 3-4, 2017	**ANALYTICAL DATE**	: APRIL 3-4, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF116/2017
MEASURING METHOD	: CHEMILUMINESCENCE	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00978/2017

TIME*	RESULT
	NITROGEN DIOXIDE
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM
	APRIL 3-4, 2017
	PAF116/2017
14:00-15:00 HOUR	0.0022
15:00-16:00 HOUR	0.0020
16:00-17:00 HOUR	0.0021
17:00-18:00 HOUR	0.0018
18:00-19:00 HOUR	0.0029
19:00-20:00 HOUR	0.0033
20:00-21:00 HOUR	0.0025
21:00-22:00 HOUR	0.0027
22:00-23:00 HOUR	0.0025
23:00-00:00 HOUR	0.0021
00:00-01:00 HOUR	0.0018
01:00-02:00 HOUR	0.0023
02:00-03:00 HOUR	0.0027
03:00-04:00 HOUR	0.0029
04:00-05:00 HOUR	0.0024
05:00-06:00 HOUR	0.0027
06:00-07:00 HOUR	0.0020
07:00-08:00 HOUR	0.0018
08:00-09:00 HOUR	0.0012
09:00-10:00 HOUR	0.0017
10:00-11:00 HOUR	0.0019
11:00-12:00 HOUR	0.0017
12:00-13:00 HOUR	0.0019
13:00-14:00 HOUR	0.0017
UNIT	ppm

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

CUSTOMER NAME : ASIAN DEVELOPMENT BANK

ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES

TEL. 0 0632 6324 444 FAX 0 0632 6362 444

MEASURING PLACE : BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET

MEASURING TYPE : AMBIENT (AIR) **RECEIVED DATE** : APRIL 5-6, 2017

MEASURING DATE : APRIL 5-6, 2017 **ANALYTICAL DATE** : APRIL 5-6, 2017

MEASURING TIME : * **ANALYSIS NO.** : PAF117/2017

MEASURING METHOD : CHEMILUMINESCENCE **WORK NO.** : FMD1622/2017

MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00979/2017

TIME*	RESULT
	NITROGEN DIOXIDE
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET
	APRIL 5-6, 2017
	PAF117/2017
09:00-10:00 HOUR	0.0067
10:00-11:00 HOUR	0.0083
11:00-12:00 HOUR	0.0066
12:00-13:00 HOUR	0.0063
13:00-14:00 HOUR	0.0055
14:00-15:00 HOUR	0.0053
15:00-16:00 HOUR	0.0047
16:00-17:00 HOUR	0.0049
17:00-18:00 HOUR	0.0051
18:00-19:00 HOUR	0.0074
19:00-20:00 HOUR	0.0132
20:00-21:00 HOUR	0.0173
21:00-22:00 HOUR	0.0077
22:00-23:00 HOUR	0.0077
23:00-00:00 HOUR	0.0078
00:00-01:00 HOUR	0.0073
01:00-02:00 HOUR	0.0063
02:00-03:00 HOUR	0.0062
03:00-04:00 HOUR	0.0060
04:00-05:00 HOUR	0.0058
05:00-06:00 HOUR	0.0048
06:00-07:00 HOUR	0.0052
07:00-08:00 HOUR	0.0058
08:00-09:00 HOUR	0.0066
UNIT	ppm

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
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APRIL 20, 2017

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Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

ANALYSIS REPORT

CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES		
	TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET		
MEASURING TYPE	: AMBIENT (AIR)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF118/2017
MEASURING METHOD	: CHEMILUMINESCENCE	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00980/2017

TIME*	RESULT
	NITROGEN DIOXIDE
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET
	APRIL 5-6, 2017
	PAF118/2017
11:00-12:00 HOUR	0.0028
12:00-13:00 HOUR	0.0047
13:00-14:00 HOUR	0.0023
14:00-15:00 HOUR	0.0036
15:00-16:00 HOUR	0.0033
16:00-17:00 HOUR	0.0029
17:00-18:00 HOUR	0.0013
18:00-19:00 HOUR	0.0019
19:00-20:00 HOUR	0.0017
20:00-21:00 HOUR	0.0025
21:00-22:00 HOUR	0.0094
22:00-23:00 HOUR	0.0077
23:00-00:00 HOUR	0.0083
00:00-01:00 HOUR	0.0038
01:00-02:00 HOUR	0.0033
02:00-03:00 HOUR	0.0031
03:00-04:00 HOUR	0.0041
04:00-05:00 HOUR	0.0046
05:00-06:00 HOUR	0.0051
06:00-07:00 HOUR	0.0029
07:00-08:00 HOUR	0.0029
08:00-09:00 HOUR	0.0027
09:00-10:00 HOUR	0.0023
10:00-11:00 HOUR	0.0026
UNIT	ppm

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

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ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON		
MEASURING TYPE	: AMBIENT (AIR)	**RECEIVED DATE**	: APRIL 3-4, 2017
MEASURING DATE	: APRIL 3-4, 2017	**ANALYTICAL DATE**	: APRIL 3-4, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF115/2017
MEASURING METHOD	: UV FLUORESCENCE	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00981/2017

TIME*	RESULT
	SULPHUR DIOXIDE
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON
	APRIL 3-4, 2017
	PAF115/2017
10:00-11:00 HOUR	0.0014
11:00-12:00 HOUR	0.0014
12:00-13:00 HOUR	0.0014
13:00-14:00 HOUR	0.0015
14:00-15:00 HOUR	0.0015
15:00-16:00 HOUR	0.0016
16:00-17:00 HOUR	0.0016
17:00-18:00 HOUR	0.0018
18:00-19:00 HOUR	0.0017
19:00-20:00 HOUR	0.0015
20:00-21:00 HOUR	0.0015
21:00-22:00 HOUR	0.0014
22:00-23:00 HOUR	0.0013
23:00-00:00 HOUR	0.0012
00:00-01:00 HOUR	0.0012
01:00-02:00 HOUR	0.0012
02:00-03:00 HOUR	0.0012
03:00-04:00 HOUR	0.0012
04:00-05:00 HOUR	0.0016
05:00-06:00 HOUR	0.0015
06:00-07:00 HOUR	0.0012
07:00-08:00 HOUR	0.0012
08:00-09:00 HOUR	0.0013
09:00-10:00 HOUR	0.0014
AVERAGE 24 HOURS	**0.0014**
UNIT	**ppm**

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

CUSTOMER NAME : ASIAN DEVELOPMENT BANK

ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444

MEASURING PLACE : BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM

MEASURING TYPE : AMBIENT (AIR) **RECEIVED DATE** : APRIL 3-4, 2017

MEASURING DATE : APRIL 3-4, 2017 **ANALYTICAL DATE** : APRIL 3-4, 2017

MEASURING TIME : * **ANALYSIS NO.** : PAF116/2017

MEASURING METHOD : UV FLUORESCENCE **WORK NO.** : FMD1622/2017

MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00982/2017

TIME*	RESULT
	SULPHUR DIOXIDE
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM
	APRIL 3-4, 2017
	PAF116/2017
14:00-15:00 HOUR	0.0021
15:00-16:00 HOUR	0.0021
16:00-17:00 HOUR	0.0023
17:00-18:00 HOUR	0.0023
18:00-19:00 HOUR	0.0024
19:00-20:00 HOUR	0.0024
20:00-21:00 HOUR	0.0024
21:00-22:00 HOUR	0.0024
22:00-23:00 HOUR	0.0029
23:00-00:00 HOUR	0.0024
00:00-01:00 HOUR	0.0020
01:00-02:00 HOUR	0.0037
02:00-03:00 HOUR	0.0028
03:00-04:00 HOUR	0.0020
04:00-05:00 HOUR	0.0026
05:00-06:00 HOUR	0.0021
06:00-07:00 HOUR	0.0024
07:00-08:00 HOUR	0.0022
08:00-09:00 HOUR	0.0022
09:00-10:00 HOUR	0.0020
10:00-11:00 HOUR	0.0023
11:00-12:00 HOUR	0.0022
12:00-13:00 HOUR	0.0024
13:00-14:00 HOUR	0.0022
AVERAGE 24 HOURS	**0.0024**
UNIT	**ppm**

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES		
	TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET		
MEASURING TYPE	: AMBIENT (AIR)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF117/2017
MEASURING METHOD	: UV FLUORESCENCE	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00983/2017

TIME*	RESULT
	SULPHUR DIOXIDE
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET
	APRIL 5-6, 2017
	PAF117/2017
09:00-10:00 HOUR	0.0015
10:00-11:00 HOUR	0.0014
11:00-12:00 HOUR	0.0013
12:00-13:00 HOUR	0.0013
13:00-14:00 HOUR	0.0013
14:00-15:00 HOUR	0.0013
15:00-16:00 HOUR	0.0013
16:00-17:00 HOUR	0.0013
17:00-18:00 HOUR	0.0014
18:00-19:00 HOUR	0.0013
19:00-20:00 HOUR	0.0013
20:00-21:00 HOUR	0.0012
21:00-22:00 HOUR	0.0012
22:00-23:00 HOUR	0.0012
23:00-00:00 HOUR	0.0012
00:00-01:00 HOUR	0.0012
01:00-02:00 HOUR	0.0012
02:00-03:00 HOUR	0.0012
03:00-04:00 HOUR	0.0012
04:00-05:00 HOUR	0.0012
05:00-06:00 HOUR	0.0012
06:00-07:00 HOUR	0.0012
07:00-08:00 HOUR	0.0011
08:00-09:00 HOUR	0.0012
AVERAGE 24 HOURS	**0.0012**
UNIT	**ppm**

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES		
	TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET		
MEASURING TYPE	: AMBIENT (AIR)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF118/2017
MEASURING METHOD	: UV FLUORESCENCE	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00984/2017

TIME*	RESULT
	SULPHUR DIOXIDE
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET
	APRIL 5-6, 2017
	PAF118/2017
11:00-12:00 HOUR	0.0025
12:00-13:00 HOUR	0.0025
13:00-14:00 HOUR	0.0026
14:00-15:00 HOUR	0.0026
15:00-16:00 HOUR	0.0027
16:00-17:00 HOUR	0.0027
17:00-18:00 HOUR	0.0029
18:00-19:00 HOUR	0.0028
19:00-20:00 HOUR	0.0026
20:00-21:00 HOUR	0.0026
21:00-22:00 HOUR	0.0025
22:00-23:00 HOUR	0.0025
23:00-00:00 HOUR	0.0025
00:00-01:00 HOUR	0.0025
01:00-02:00 HOUR	0.0025
02:00-03:00 HOUR	0.0025
03:00-04:00 HOUR	0.0024
04:00-05:00 HOUR	0.0025
05:00-06:00 HOUR	0.0025
06:00-07:00 HOUR	0.0027
07:00-08:00 HOUR	0.0024
08:00-09:00 HOUR	0.0024
09:00-10:00 HOUR	0.0028
10:00-11:00 HOUR	0.0026
AVERAGE 24 HOURS	**0.0026**
UNIT	**ppm**

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON		
MEASURING TYPE	: AMBIENT (VIBRATION)	**RECEIVED DATE**	: APRIL 3-4, 2017
MEASURING DATE	: APRIL 3-4, 2017	**ANALYTICAL DATE**	: APRIL 3-4, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF115/2017
MEASURING METHOD	: VIBRATION METER [1/2/]	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00985/2015

TIME*	RESULT					
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON					
	TRANSVERSE				VERTICAL	
	X-AXIS		Y-AXIS		Z-AXIS	
	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)
APRIL 3-4, 2017 PAF115/2017	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]

REMARK: * MEASURING FROM 10:00 HOUR ON APRIL 3, 2017 TO 10:00 HOUR ON APRIL 4, 2017

[1/] RESOLUTION 0.127 mm/s

[2/] TRIGGER SOURCE 0.510 mm/s

[3/] NONEXISTENT ZC FREQUENCY

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM		
MEASURING TYPE	: AMBIENT (VIBRATION)	**RECEIVED DATE**	: APRIL 3-4, 2017
MEASURING DATE	: APRIL 3-4, 2017	**ANALYTICAL DATE**	: APRIL 3-4, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF116/2017
MEASURING METHOD	: VIBRATION METER [1/,2/]	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00986/2015

TIME*	RESULT					
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM					
	TRANSVERSE				VERTICAL	
	X-AXIS		Y-AXIS		Z-AXIS	
	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)
APRIL 3-4, 2017 PAF116/2017	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]

REMARK: * MEASURING FROM 14:00 HOUR ON APRIL 3, 2017 TO 14:00 HOUR ON APRIL 4, 2017

[1/] RESOLUTION 0.127 mm/s

[2/] TRIGGER SOURCE 0.510 mm/s

[3/] NONEXISTENT ZC FREQUENCY

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

ANALYSIS REPORT

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET
MEASURING TYPE : AMBIENT (VIBRATION) **RECEIVED DATE** : APRIL 5-6, 2017
MEASURING DATE : APRIL 5-6, 2017 **ANALYTICAL DATE** : APRIL 5-6, 2017
MEASURING TIME : * **ANALYSIS NO.** : PAF117/2017
MEASURING METHOD : VIBRATION METER [1/2/] **WORK NO.** : FMD1622/2017
MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00987/2015

TIME*	RESULT					
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET					
	TRANSVERSE				VERTICAL	
	X-AXIS		Y-AXIS		Z-AXIS	
	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)
APRIL 5-6, 2017 PAF117/2017	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]

REMARK: * MEASURING FROM 09:00 HOUR ON APRIL 3, 2017 TO 09:00 HOUR ON APRIL 4, 2017
[1/] RESOLUTION 0.127 mm/s
[2/] TRIGGER SOURCE 0.510 mm/s
[3/] NONEXISTENT ZC FREQUENCY

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET		
MEASURING TYPE	: AMBIENT (VIBRATION)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF118/2017
MEASURING METHOD	: VIBRATION METER [1/2/]	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00988/2015

TIME*	RESULT					
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET					
	TRANSVERSE				VERTICAL	
	X-AXIS		Y-AXIS		Z-AXIS	
	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)	VELOCITY (mm/s)	FREQUENCY (Hz)
APRIL 5-6, 2017 PAF118/2017	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]	<0.127	NOT APPLICABLE [3/]

REMARK: * MEASURING FROM 11:00 HOUR ON APRIL 3, 2017 TO 11:00 HOUR ON APRIL 4, 2017

[1/] RESOLUTION 0.127 mm/s

[2/] TRIGGER SOURCE 0.510 mm/s

[3/] NONEXISTENT ZC FREQUENCY

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

UNITED ANALYST AND ENGINEERING CONSULTANT COMPANY LIMITED

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ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON		
MEASURING TYPE	: AMBIENT (NOISE)	**RECEIVED DATE**	: APRIL 3-4, 2017
MEASURING DATE	: APRIL 3-4, 2017	**ANALYTICAL DATE**	: APRIL 3-4, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF115/2017
MEASURING EQUIPMENT	: INTEGRATED SOUND LEVEL METER	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00989/2017

TIME*	RESULT BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON APRIL 3-4, 2017 PAF115/2017		
	$L_{Aeq\ 1\ hour}$	L_{Amax}	L_{A90}
10:00-11:00 HOUR	57.4	82.8	50.6
11:00-12:00 HOUR	57.5	74.1	51.4
12:00-13:00 HOUR	57.5	72.2	51.1
13:00-14:00 HOUR	56.5	70.9	50.1
14:00-15:00 HOUR	56.8	72.2	50.8
15:00-16:00 HOUR	56.6	69.9	49.1
16:00-17:00 HOUR	57.8	73.9	51.3
17:00-18:00 HOUR	65.0	85.8	52.3
18:00-19:00 HOUR	57.6	70.1	50.9
19:00-20:00 HOUR	56.1	68.2	48.7
20:00-21:00 HOUR	55.7	68.0	48.7
21:00-22:00 HOUR	54.9	68.5	46.6
22:00-23:00 HOUR	53.9	67.4	44.8
23:00-00:00 HOUR	53.1	70.7	44.4
00:00-01:00 HOUR	50.9	67.0	42.8
01:00-02:00 HOUR	51.8	71.2	44.0
02:00-03:00 HOUR	52.3	65.9	45.0
03:00-04:00 HOUR	54.1	72.1	43.7
04:00-05:00 HOUR	55.4	71.7	45.3
05:00-06:00 HOUR	57.5	74.0	50.5
06:00-07:00 HOUR	58.1	79.5	50.3
07:00-08:00 HOUR	57.8	75.5	52.2
08:00-09:00 HOUR	57.6	71.4	51.9
09:00-10:00 HOUR	57.1	77.2	50.9
$L_{Aeq\ 24\ hours}$	57.3		
L_{Adn}	62.9		
UNIT	dB(A)		

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM
MEASURING TYPE : AMBIENT (NOISE) **RECEIVED DATE** : APRIL 3-4, 2017
MEASURING DATE : APRIL 3-4, 2017 **ANALYTICAL DATE** : APRIL 3-4, 2017
MEASURING TIME : * **ANALYSIS NO.** : PAF116/2017
MEASURING EQUIPMENT : INTEGRATED SOUND LEVEL METER **WORK NO.** : FMD1622/2017
MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00990/2017

TIME*	RESULT		
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM		
	APRIL 3-4, 2017		
	PAF116/2017		
	$L_{Aeq\ 1\ hour}$	L_{Amax}	L_{A90}
14:00-15:00 HOUR	47.7	69.9	44.3
15:00-16:00 HOUR	46.5	63.9	41.8
16:00-17:00 HOUR	47.3	66.4	42.6
17:00-18:00 HOUR	46.8	65.1	43.1
18:00-19:00 HOUR	50.0	64.1	44.2
19:00-20:00 HOUR	45.8	57.4	44.0
20:00-21:00 HOUR	44.8	56.6	42.1
21:00-22:00 HOUR	43.9	59.8	41.2
22:00-23:00 HOUR	43.1	60.2	40.8
23:00-00:00 HOUR	42.5	54.3	41.0
00:00-01:00 HOUR	42.4	58.7	40.9
01:00-02:00 HOUR	41.4	58.6	40.5
02:00-03:00 HOUR	41.7	58.2	40.5
03:00-04:00 HOUR	45.2	66.7	40.5
04:00-05:00 HOUR	43.9	58.5	40.7
05:00-06:00 HOUR	50.9	64.1	43.4
06:00-07:00 HOUR	52.4	71.3	45.9
07:00-08:00 HOUR	61.3	76.2	45.6
08:00-09:00 HOUR	49.6	71.3	43.3
09:00-10:00 HOUR	48.0	65.0	43.0
10:00-11:00 HOUR	51.2	70.6	49.1
11:00-12:00 HOUR	50.6	68.7	48.3
12:00-13:00 HOUR	49.2	69.3	46.8
13:00-14:00 HOUR	51.5	72.6	47.1
$L_{Aeq\ 24\ hours}$		**50.7**	
L_{Adn}		**59.9**	
UNIT		dB(A)	

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

United Analyst and Engineering Consultant Co., Ltd.
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ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET		
MEASURING TYPE	: AMBIENT (NOISE)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF117/2017
MEASURING EQUIPMENT	: INTEGRATED SOUND LEVEL METER	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00991/2017

TIME*	RESULT BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET APRIL 5-6, 2017 PAF117/2017		
	$L_{Aeq\ 1\ hour}$	L_{Amax}	L_{A90}
09:00-10:00 HOUR	54.4	80.0	48.8
10:00-11:00 HOUR	55.0	68.3	50.4
11:00-12:00 HOUR	55.0	69.6	49.7
12:00-13:00 HOUR	55.3	73.9	50.1
13:00-14:00 HOUR	54.7	74.4	49.9
14:00-15:00 HOUR	54.8	66.2	49.6
15:00-16:00 HOUR	54.4	68.0	49.8
16:00-17:00 HOUR	58.0	83.3	49.9
17:00-18:00 HOUR	57.5	84.4	49.6
18:00-19:00 HOUR	56.5	74.7	48.3
19:00-20:00 HOUR	52.1	65.7	46.6
20:00-21:00 HOUR	52.3	71.5	45.0
21:00-22:00 HOUR	51.3	68.1	45.5
22:00-23:00 HOUR	50.0	71.2	43.9
23:00-00:00 HOUR	50.0	67.4	43.5
00:00-01:00 HOUR	48.1	66.4	41.2
01:00-02:00 HOUR	49.0	59.2	42.8
02:00-03:00 HOUR	47.0	60.6	41.5
03:00-04:00 HOUR	48.6	65.4	42.4
04:00-05:00 HOUR	50.5	64.4	43.9
05:00-06:00 HOUR	53.2	67.5	45.4
06:00-07:00 HOUR	52.8	74.3	45.4
07:00-08:00 HOUR	54.2	68.4	47.4
08:00-09:00 HOUR	53.8	75.8	47.8
$L_{Aeq\ 24\ hours}$	**53.8**		
L_{Adn}	**58.6**		
UNIT	**dB(A)**		

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ANALYSIS REPORT

PROJECT NAME	: AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING		
CUSTOMER NAME	: ASIAN DEVELOPMENT BANK		
ADDRESS	: 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES TEL. 0 0632 6324 444 FAX 0 0632 6362 444		
MEASURING PLACE	: THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET		
MEASURING TYPE	: AMBIENT (NOISE)	**RECEIVED DATE**	: APRIL 5-6, 2017
MEASURING DATE	: APRIL 5-6, 2017	**ANALYTICAL DATE**	: APRIL 5-6, 2017
MEASURING TIME	: *	**ANALYSIS NO.**	: PAF118/2017
MEASURING EQUIPMENT	: INTEGRATED SOUND LEVEL METER	**WORK NO.**	: FMD1622/2017
MEASURED BY	: MR PAIRAT KUMNERDRAKSA	**REPORT NO.**	: F00992/2017

TIME*	RESULT THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET APRIL 5-6, 2017 PAF118/2017		
	$L_{Aeq\ 1\ hour}$	L_{Amax}	L_{A90}
11:00-12:00 HOUR	50.8	70.6	47.2
12:00-13:00 HOUR	49.8	70.2	46.4
13:00-14:00 HOUR	49.5	66.5	46.4
14:00-15:00 HOUR	50.0	64.3	46.6
15:00-16:00 HOUR	51.3	67.8	47.7
16:00-17:00 HOUR	51.0	69.0	46.9
17:00-18:00 HOUR	52.8	73.1	46.8
18:00-19:00 HOUR	51.7	67.7	47.1
19:00-20:00 HOUR	49.6	67.9	47.6
20:00-21:00 HOUR	49.4	66.2	47.7
21:00-22:00 HOUR	49.1	59.8	47.7
22:00-23:00 HOUR	49.4	65.0	47.7
23:00-00:00 HOUR	48.0	60.6	45.8
00:00-01:00 HOUR	47.3	58.4	46.0
01:00-02:00 HOUR	47.4	57.1	45.8
02:00-03:00 HOUR	47.8	68.5	46.1
03:00-04:00 HOUR	48.0	65.8	47.0
04:00-05:00 HOUR	47.9	63.6	45.5
05:00-06:00 HOUR	53.4	79.1	44.8
06:00-07:00 HOUR	60.5	82.3	47.1
07:00-08:00 HOUR	50.8	69.2	46.7
08:00-09:00 HOUR	50.5	69.5	46.3
09:00-10:00 HOUR	52.9	76.9	47.5
10:00-11:00 HOUR	55.0	81.2	48.5
$L_{Aeq\ 24\ hours}$	**52.0**		
L_{Adn}	**60.0**		
UNIT	**dB(A)**		

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ใบรายงานผลการวิเคราะห์

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON
MEASURING TYPE : INTEGRATED SOUND LEVEL METER
MEASURING DATE : APRIL 3-4, 2017
MEASURING TIME : *
MEASURING EQUIPMEN : INTEGRATED SOUND LEVEL METER
MEASURED BY : MR PAIRAT KUMNERDRAKSA
RECEIVED DATE : APRIL 3-4, 2017
ANALYTICAL DATE : APRIL 3-4, 2017
ANALYSIS NO. : PAF115/2017
WORK NO. : FMD1622/2017
REPORT NO. : F00993/2017

TIME*	RESULT	
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON	
	APRIL 3- 4, 2017	
	PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
10:00-10:05 น.	61.7	50.6
10:05-10:10 น.	57.3	51.6
10:10-10:15 น.	57.7	51.9
10:15-10:20 น.	56.8	50.4
10:20-10:25 น.	56.7	50.3
10:25-10:30 น.	57.4	51.6
10:30-10:35 น.	57.0	50.5
10:35-10:40 น.	55.7	50.2
10:40-10:45 น.	56.6	51.3
10:45-10:50 น.	55.9	49.5
10:50-10:55 น.	55.9	50.9
10:55-11:00 น.	56.0	49.5
11:00-11:05 น.	55.9	50.5
11:05-11:10 น.	55.7	49.6
11:10-11:15 น.	55.8	48.9
11:15-11:20 น.	56.9	50.6
11:20-11:25 น.	58.2	52.6
11:25-11:30 น.	58.5	53.4
11:30-11:35 น.	57.5	54.0
11:35-11:40 น.	58.0	53.2
11:40-11:45 น.	57.6	51.9
11:45-11:50 น.	59.0	53.5
11:50-11:55 น.	58.2	50.9
11:55-12:00 น.	56.6	50.5
12:00-12:05 น.	57.2	51.2
12:05-12:10 น.	57.0	51.6
12:10-12:15 น.	57.1	51.0
12:15-12:20 น.	55.6	49.6
12:20-12:25 น.	57.3	50.8
12:25-12:30 น.	56.2	49.0
12:30-12:35 น.	55.7	47.9
12:35-12:40 น.	59.8	55.9
12:40-12:45 น.	58.7	53.8
12:45-12:50 น.	58.5	55.3
12:50-12:55 น.	57.3	52.6
UNIT	dB(A)	

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TIME*	RESULT BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON APRIL 3- 4, 2017 PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A50}
12:55-13:00 น.	57.7	51.0
13:00-13:05 น.	55.9	50.2
13:05-13:10 น.	56.5	50.4
13:10-13:15 น.	56.5	49.7
13:15-13:20 น.	57.6	49.3
13:20-13:25 น.	56.1	50.1
13:25-13:30 น.	57.4	50.5
13:30-13:35 น.	57.6	49.8
13:35-13:40 น.	54.9	48.9
13:40-13:45 น.	56.6	50.0
13:45-13:50 น.	56.1	50.7
13:50-13:55 น.	55.2	49.5
13:55-14:00 น.	57.0	50.5
14:00-14:05 น.	56.7	51.4
14:05-14:10 น.	57.4	53.8
14:10-14:15 น.	58.0	53.9
14:15-14:20 น.	57.4	52.1
14:20-14:25 น.	55.4	49.0
14:25-14:30 น.	57.0	48.1
14:30-14:35 น.	56.0	50.0
14:35-14:40 น.	56.2	51.3
14:40-14:45 น.	58.3	50.7
14:45-14:50 น.	54.8	47.8
14:50-14:55 น.	56.5	50.9
14:55-15:00 น.	56.7	50.4
15:00-15:05 น.	56.7	49.4
15:05-15:10 น.	57.2	51.1
15:10-15:15 น.	55.6	48.2
15:15-15:20 น.	56.8	47.5
15:20-15:25 น.	57.5	50.0
15:25-15:30 น.	56.3	48.2
15:30-15:35 น.	58.4	54.1
15:35-15:40 น.	56.4	51.0
15:40-15:45 น.	56.2	51.1
15:45-15:50 น.	56.2	48.1
15:50-15:55 น.	55.0	48.7
15:55-16:00 น.	55.8	48.1
16:00-16:05 น.	57.5	50.1
16:05-16:10 น.	59.3	56.8
16:10-16:15 น.	58.9	53.4
16:15-16:20 น.	58.6	54.3
16:20-16:25 น.	57.2	51.4
16:25-16:30 น.	56.9	51.7
16:30-16:35 น.	56.3	50.3
16:35-16:40 น.	58.6	49.5
16:40-16:45 น.	56.3	49.5
16:45-16:50 น.	56.7	50.6
16:50-16:55 น.	57.8	51.2
16:55-17:00 น.	58.6	53.1
UNIT	dB(A)	

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TIME*	RESULT BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON APRIL 3- 4, 2017 PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
17:00-17:05 น.	59.2	51.6
17:05-17:10 น.	58.1	52.3
17:10-17:15 น.	58.7	52.4
17:15-17:20 น.	57.8	51.3
17:20-17:25 น.	58.0	52.4
17:25-17:30 น.	69.5	51.4
17:30-17:35 น.	72.0	58.9
17:35-17:40 น.	62.6	52.5
17:40-17:45 น.	57.9	52.3
17:45-17:50 น.	65.9	53.5
17:50-17:55 น.	63.2	52.3
17:55-18:00 น.	60.9	50.7
18:00-18:05 น.	58.3	50.4
18:05-18:10 น.	57.8	49.9
18:10-18:15 น.	61.0	57.0
18:15-18:20 น.	59.7	55.4
18:20-18:25 น.	57.1	52.2
18:25-18:30 น.	57.2	52.0
18:30-18:35 น.	55.7	49.2
18:35-18:40 น.	56.6	50.9
18:40-18:45 น.	55.1	47.5
18:45-18:50 น.	56.7	52.5
18:50-18:55 น.	56.7	50.8
18:55-19:00 น.	55.6	48.5
19:00-19:05 น.	56.0	47.6
19:05-19:10 น.	57.9	52.6
19:10-19:15 น.	55.1	48.4
19:15-19:20 น.	56.5	49.7
19:20-19:25 น.	56.7	48.8
19:25-19:30 น.	56.2	48.6
19:30-19:35 น.	55.1	49.8
19:35-19:40 น.	54.2	48.6
19:40-19:45 น.	54.8	46.4
19:45-19:50 น.	56.0	49.1
19:50-19:55 น.	57.9	50.4
19:55-20:00 น.	55.6	45.5
20:00-20:05 น.	55.8	48.5
20:05-20:10 น.	56.5	49.4
20:10-20:15 น.	56.7	48.8
20:15-20:20 น.	55.6	48.8
20:20-20:25 น.	55.5	48.7
20:25-20:30 น.	55.8	49.8
20:30-20:35 น.	54.3	47.1
20:35-20:40 น.	55.3	47.2
20:40-20:45 น.	56.6	49.4
20:45-20:50 น.	54.5	47.8
20:50-20:55 น.	55.9	48.6
20:55-21:00 น.	55.8	47.5
21:00-21:05 น.	54.5	45.9
UNIT	dB(A)	

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TIME*	RESULT BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON APRIL 3- 4, 2017 PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
21:05-21:10 น.	53.8	45.1
21:10-21:15 น.	55.2	48.6
21:15-21:20 น.	55.0	47.2
21:20-21:25 น.	55.6	47.2
21:25-21:30 น.	53.2	45.2
21:30-21:35 น.	53.5	44.9
21:35-21:40 น.	57.1	48.3
21:40-21:45 น.	53.8	46.0
21:45-21:50 น.	55.9	49.6
21:50-21:55 น.	54.5	48.8
21:55-22:00 น.	54.9	45.8
22:00-22:05 น.	55.1	48.5
22:05-22:10 น.	55.2	48.3
22:10-22:15 น.	54.8	46.1
22:15-22:20 น.	55.4	47.6
22:20-22:25 น.	50.9	44.3
22:25-22:30 น.	54.2	44.8
22:30-22:35 น.	51.5	43.8
22:35-22:40 น.	53.6	44.1
22:40-22:45 น.	53.8	44.0
22:45-22:50 น.	52.8	43.6
22:50-22:55 น.	52.0	44.8
22:55-23:00 น.	54.6	46.1
23:00-23:05 น.	55.2	46.7
23:05-23:10 น.	53.7	44.7
23:10-23:15 น.	50.5	43.4
23:15-23:20 น.	50.8	43.5
23:20-23:25 น.	48.9	43.0
23:25-23:30 น.	52.3	43.9
23:30-23:35 น.	49.3	43.9
23:35-23:40 น.	52.8	44.1
23:40-23:45 น.	54.2	44.7
23:45-23:50 น.	50.3	45.0
23:50-23:55 น.	57.7	47.7
23:55-00:00 น.	52.0	45.3
00:00-00:05 น.	51.6	42.3
00:05-00:10 น.	49.9	42.6
00:10-00:15 น.	50.2	43.1
00:15-00:20 น.	51.7	43.8
00:20-00:25 น.	52.3	43.4
00:25-00:30 น.	47.5	42.9
00:30-00:35 น.	50.4	42.7
00:35-00:40 น.	50.8	41.7
00:40-00:45 น.	50.3	42.3
00:45-00:50 น.	51.3	42.1
00:50-00:55 น.	50.3	44.4
00:55-01:00 น.	52.6	45.0
01:00-01:05 น.	51.6	43.5
01:05-01:10 น.	51.4	43.0
UNIT	dB(A)	

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TIME*	RESULT	
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON	
	APRIL 3- 4, 2017	
	PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
01:10-01:15 น.	49.7	42.9
01:15-01:20 น.	51.2	42.9
01:20-01:25 น.	53.2	43.5
01:25-01:30 น.	52.1	44.0
01:30-01:35 น.	48.9	43.9
01:35-01:40 น.	53.7	46.1
01:40-01:45 น.	52.4	46.4
01:45-01:50 น.	54.4	46.5
01:50-01:55 น.	46.8	44.7
01:55-02:00 น.	51.3	44.8
02:00-02:05 น.	51.5	44.9
02:05-02:10 น.	53.0	45.8
02:10-02:15 น.	53.5	45.4
02:15-02:20 น.	51.3	44.9
02:20-02:25 น.	54.5	45.8
02:25-02:30 น.	51.9	45.1
02:30-02:35 น.	50.5	44.9
02:35-02:40 น.	53.2	41.6
02:40-02:45 น.	50.3	42.2
02:45-02:50 น.	51.5	44.2
02:50-02:55 น.	52.4	45.7
02:55-03:00 น.	52.3	46.0
03:00-03:05 น.	49.1	44.7
03:05-03:10 น.	51.4	44.7
03:10-03:15 น.	52.5	41.4
03:15-03:20 น.	53.8	45.7
03:20-03:25 น.	54.4	43.5
03:25-03:30 น.	55.6	44.6
03:30-03:35 น.	57.2	42.9
03:35-03:40 น.	56.6	48.6
03:40-03:45 น.	54.5	40.2
03:45-03:50 น.	52.9	41.5
03:50-03:55 น.	49.6	40.7
03:55-04:00 น.	53.7	43.8
04:00-04:05 น.	54.6	42.7
04:05-04:10 น.	57.0	48.3
04:10-04:15 น.	52.4	42.2
04:15-04:20 น.	57.3	46.5
04:20-04:25 น.	55.7	44.3
04:25-04:30 น.	54.9	44.3
04:30-04:35 น.	55.9	45.8
04:35-04:40 น.	54.4	43.2
04:40-04:45 น.	55.5	45.1
04:45-04:50 น.	55.8	50.2
04:50-04:55 น.	53.8	46.3
04:55-05:00 น.	55.5	45.5
05:00-05:05 น.	55.6	45.4
05:05-05:10 น.	56.1	48.1
05:10-05:15 น.	58.0	53.2
UNIT	dB(A)	

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TIME*	RESULT BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON APRIL 3- 4, 2017 PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
05:15-05:20 น.	57.4	52.5
05:20-05:25 น.	58.9	49.5
05:25-05:30 น.	57.6	51.5
05:30-05:35 น.	57.7	48.9
05:35-05:40 น.	55.8	49.2
05:40-05:45 น.	58.6	48.4
05:45-05:50 น.	57.9	51.9
05:50-05:55 น.	58.1	52.7
05:55-06:00 น.	57.3	51.8
06:00-06:05 น.	57.2	49.5
06:05-06:10 น.	57.2	49.4
06:10-06:15 น.	56.6	50.4
06:15-06:20 น.	56.7	49.3
06:20-06:25 น.	58.4	50.2
06:25-06:30 น.	57.8	51.5
06:30-06:35 น.	58.3	51.9
06:35-06:40 น.	57.4	51.9
06:40-06:45 น.	58.3	50.8
06:45-06:50 น.	58.5	51.5
06:50-06:55 น.	61.6	49.8
06:55-07:00 น.	56.8	49.0
07:00-07:05 น.	56.5	50.4
07:05-07:10 น.	59.3	52.1
07:10-07:15 น.	58.9	52.5
07:15-07:20 น.	57.2	51.2
07:20-07:25 น.	58.1	52.4
07:25-07:30 น.	58.3	52.2
07:30-07:35 น.	57.3	51.3
07:35-07:40 น.	57.8	51.4
07:40-07:45 น.	57.5	52.3
07:45-07:50 น.	56.7	52.2
07:50-07:55 น.	58.0	52.6
07:55-08:00 น.	56.9	51.0
08:00-08:05 น.	57.8	50.9
08:05-08:10 น.	57.0	52.3
08:10-08:15 น.	58.9	51.4
08:15-08:20 น.	56.8	51.2
08:20-08:25 น.	57.9	52.4
08:25-08:30 น.	58.6	52.4
08:30-08:35 น.	58.0	52.5
08:35-08:40 น.	58.8	52.3
08:40-08:45 น.	55.6	49.8
08:45-08:50 น.	56.3	50.6
08:50-08:55 น.	56.7	50.6
08:55-09:00 น.	57.7	52.3
09:00-09:05 น.	59.4	47.8
09:05-09:10 น.	56.0	51.2
09:10-09:15 น.	57.2	52.2
09:15-09:20 น.	57.5	51.5
UNIT	dB(A)	

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TIME*	RESULT	
	BAN KUDCHICK-NASOMBOON SCHOOL,SAKON NAKHON	
	APRIL 3- 4, 2017	
	PAF115/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
09:20-09:25 น.	57.4	51.1
09:25-09:30 น.	56.5	50.1
09:30-09:35 น.	57.0	49.9
09:35-09:40 น.	56.3	49.2
09:40-09:45 น.	56.7	51.1
09:45-09:50 น.	57.9	52.3
09:50-09:55 น.	56.2	50.6
09:55-10:00 น.	55.9	49.7
UNIT	dB(A)	

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

United Analyst and Engineering Consultant Co., Ltd.
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ใบรายงานผลการวิเคราะห์

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM
MEASURING TYPE : INTEGRATED SOUND LEVEL METER **RECEIVED DATE** : APRIL 3-4, 2017
MEASURING DATE : APRIL 3-4, 2017 **ANALYTICAL DATE** : APRIL 3-4, 2017
MEASURING TIME : * **ANALYSIS NO.** : PAF116/2017
MEASURING EQUIPMEN : INTEGRATED SOUND LEVEL METER **WORK NO.** : FMD1622/2017
MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00994/2017

TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
14:00-14:05 น.	47.5	42.9
14:05-14:10 น.	46.7	43.8
14:10-14:15 น.	47.3	44.5
14:15-14:20 น.	47.1	43.8
14:20-14:25 น.	47.0	43.8
14:25-14:30 น.	49.2	45.4
14:30-14:35 น.	46.3	43.8
14:35-14:40 น.	47.8	44.8
14:40-14:45 น.	47.9	44.1
14:45-14:50 น.	49.4	44.8
14:50-14:55 น.	47.4	44.5
14:55-15:00 น.	47.4	44.9
15:00-15:05 น.	46.8	44.0
15:05-15:10 น.	46.4	43.9
15:10-15:15 น.	47.3	43.8
15:15-15:20 น.	45.0	41.6
15:20-15:25 น.	48.9	42.2
15:25-15:30 น.	44.3	41.2
15:30-15:35 น.	45.6	41.5
15:35-15:40 น.	47.2	42.3
15:40-15:45 น.	46.9	41.9
15:45-15:50 น.	46.9	41.4
15:50-15:55 น.	45.1	41.7
15:55-16:00 น.	44.9	41.5
16:00-16:05 น.	47.9	41.8
16:05-16:10 น.	46.8	42.2
16:10-16:15 น.	47.4	41.6
16:15-16:20 น.	45.8	42.6
16:20-16:25 น.	47.9	42.5
16:25-16:30 น.	48.3	43.2
16:30-16:35 น.	46.6	42.9
16:35-16:40 น.	46.5	42.5
16:40-16:45 น.	46.6	42.8
16:45-16:50 น.	45.7	42.1
16:50-16:55 น.	46.6	43.0
UNIT	dB(A)	

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TIME*	RESULT BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM APRIL 3- 4, 2017 PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
16:55-17:00 น.	49.6	44.6
17:00-17:05 น.	46.9	44.3
17:05-17:10 น.	47.5	42.6
17:10-17:15 น.	48.0	44.9
17:15-17:20 น.	47.2	43.1
17:20-17:25 น.	47.5	41.8
17:25-17:30 น.	46.9	42.7
17:30-17:35 น.	46.0	43.6
17:35-17:40 น.	45.7	43.1
17:40-17:45 น.	45.8	43.1
17:45-17:50 น.	46.3	42.7
17:50-17:55 น.	46.8	43.2
17:55-18:00 น.	46.1	43.2
18:00-18:05 น.	45.7	42.8
18:05-18:10 น.	46.5	43.1
18:10-18:15 น.	46.6	42.9
18:15-18:20 น.	47.4	43.2
18:20-18:25 น.	45.9	43.2
18:25-18:30 น.	49.9	43.1
18:30-18:35 น.	56.6	51.5
18:35-18:40 น.	51.0	48.9
18:40-18:45 น.	48.5	46.1
18:45-18:50 น.	49.4	46.0
18:50-18:55 น.	50.2	46.4
18:55-19:00 น.	46.7	45.2
19:00-19:05 น.	46.3	45.1
19:05-19:10 น.	47.1	46.0
19:10-19:15 น.	46.6	44.9
19:15-19:20 น.	45.8	44.7
19:20-19:25 น.	45.8	44.0
19:25-19:30 น.	45.3	42.5
19:30-19:35 น.	44.8	43.4
19:35-19:40 น.	45.6	44.0
19:40-19:45 น.	44.8	43.1
19:45-19:50 น.	45.7	43.5
19:50-19:55 น.	46.1	44.0
19:55-20:00 น.	45.3	43.8
20:00-20:05 น.	44.9	43.5
20:05-20:10 น.	44.4	42.4
20:10-20:15 น.	45.5	42.7
20:15-20:20 น.	44.4	42.1
20:20-20:25 น.	45.8	42.4
20:25-20:30 น.	44.2	41.5
20:30-20:35 น.	43.1	41.6
20:35-20:40 น.	44.9	42.5
20:40-20:45 น.	44.3	41.9
20:45-20:50 น.	45.0	41.9
20:50-20:55 น.	43.6	42.1
20:55-21:00 น.	46.1	41.8
UNIT	dB(A)	

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TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
21:00-21:05 น.	43.5	41.8
21:05-21:10 น.	43.8	41.6
21:10-21:15 น.	43.7	42.2
21:15-21:20 น.	44.1	42.1
21:20-21:25 น.	43.4	41.5
21:25-21:30 น.	45.9	41.3
21:30-21:35 น.	46.9	41.1
21:35-21:40 น.	41.9	40.7
21:40-21:45 น.	42.5	40.7
21:45-21:50 น.	43.5	40.2
21:50-21:55 น.	42.2	40.7
21:55-22:00 น.	41.4	40.6
22:00-22:05 น.	41.3	40.5
22:05-22:10 น.	42.0	40.6
22:10-22:15 น.	42.9	40.8
22:15-22:20 น.	43.6	40.8
22:20-22:25 น.	42.5	40.2
22:25-22:30 น.	43.2	40.8
22:30-22:35 น.	42.4	41.0
22:35-22:40 น.	47.0	41.2
22:40-22:45 น.	43.1	40.7
22:45-22:50 น.	42.6	40.5
22:50-22:55 น.	41.6	40.6
22:55-23:00 น.	41.8	40.8
23:00-23:05 น.	43.0	41.5
23:05-23:10 น.	43.5	41.0
23:10-23:15 น.	43.2	41.2
23:15-23:20 น.	43.2	41.0
23:20-23:25 น.	41.9	41.0
23:25-23:30 น.	42.4	41.1
23:30-23:35 น.	41.5	40.8
23:35-23:40 น.	41.8	41.0
23:40-23:45 น.	42.7	41.1
23:45-23:50 น.	42.3	41.0
23:50-23:55 น.	42.3	41.0
23:55-00:00 น.	42.2	41.0
00:00-00:05 น.	42.1	41.1
00:05-00:10 น.	43.2	41.0
00:10-00:15 น.	44.2	40.8
00:15-00:20 น.	42.1	41.0
00:20-00:25 น.	41.3	40.9
00:25-00:30 น.	41.8	40.9
00:30-00:35 น.	42.6	41.2
00:35-00:40 น.	41.9	41.1
00:40-00:45 น.	42.4	40.8
00:45-00:50 น.	41.0	40.4
00:50-00:55 น.	42.5	40.4
00:55-01:00 น.	43.2	40.6
01:00-01:05 น.	40.9	40.4
UNIT	dB(A)	

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TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
01:05-01:10 น.	41.3	40.3
01:10-01:15 น.	41.3	40.5
01:15-01:20 น.	41.6	40.5
01:20-01:25 น.	41.3	40.5
01:25-01:30 น.	41.4	40.5
01:30-01:35 น.	41.2	40.5
01:35-01:40 น.	43.0	40.6
01:40-01:45 น.	40.9	40.4
01:45-01:50 น.	40.8	40.3
01:50-01:55 น.	41.7	40.5
01:55-02:00 น.	40.8	40.3
02:00-02:05 น.	41.1	40.3
02:05-02:10 น.	41.0	40.3
02:10-02:15 น.	41.6	40.5
02:15-02:20 น.	40.6	40.3
02:20-02:25 น.	41.0	40.3
02:25-02:30 น.	41.6	40.4
02:30-02:35 น.	41.2	40.3
02:35-02:40 น.	43.3	40.6
02:40-02:45 น.	41.4	40.5
02:45-02:50 น.	41.6	40.5
02:50-02:55 น.	43.5	40.5
02:55-03:00 น.	41.2	40.5
03:00-03:05 น.	42.0	40.4
03:05-03:10 น.	45.3	40.6
03:10-03:15 น.	41.6	40.4
03:15-03:20 น.	41.7	40.5
03:20-03:25 น.	40.7	40.2
03:25-03:30 น.	41.3	40.4
03:30-03:35 น.	41.8	40.3
03:35-03:40 น.	49.2	40.4
03:40-03:45 น.	49.8	40.5
03:45-03:50 น.	48.1	40.8
03:50-03:55 น.	41.3	40.5
03:55-04:00 น.	43.8	41.1
04:00-04:05 น.	45.2	41.1
04:05-04:10 น.	42.0	40.5
04:10-04:15 น.	41.8	40.5
04:15-04:20 น.	42.4	40.6
04:20-04:25 น.	44.3	40.7
04:25-04:30 น.	43.1	40.7
04:30-04:35 น.	43.5	40.7
04:35-04:40 น.	43.3	40.7
04:40-04:45 น.	45.6	40.6
04:45-04:50 น.	44.8	41.1
04:50-04:55 น.	44.8	40.6
04:55-05:00 น.	44.1	40.6
05:00-05:05 น.	44.4	41.0
05:05-05:10 น.	46.2	41.2
UNIT	dB(A)	

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TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
05:10-05:15 น.	44.6	40.7
05:15-05:20 น.	45.2	41.1
05:20-05:25 น.	46.6	42.0
05:25-05:30 น.	47.9	43.2
05:30-05:35 น.	53.5	51.3
05:35-05:40 น.	52.8	51.3
05:40-05:45 น.	49.7	46.2
05:45-05:50 น.	51.7	43.6
05:50-05:55 น.	56.0	44.1
05:55-06:00 น.	52.5	45.8
06:00-06:05 น.	47.9	44.9
06:05-06:10 น.	50.7	45.8
06:10-06:15 น.	48.5	46.0
06:15-06:20 น.	51.0	46.0
06:20-06:25 น.	52.5	45.6
06:25-06:30 น.	49.1	45.9
06:30-06:35 น.	50.1	46.3
06:35-06:40 น.	59.7	46.0
06:40-06:45 น.	51.7	45.1
06:45-06:50 น.	50.4	47.1
06:50-06:55 น.	49.3	45.6
06:55-07:00 น.	49.7	45.6
07:00-07:05 น.	59.3	46.5
07:05-07:10 น.	63.6	50.4
07:10-07:15 น.	67.7	63.2
07:15-07:20 น.	65.3	48.3
07:20-07:25 น.	64.9	50.6
07:25-07:30 น.	55.6	44.9
07:30-07:35 น.	49.5	46.1
07:35-07:40 น.	49.5	45.0
07:40-07:45 น.	51.5	44.6
07:45-07:50 น.	48.2	44.2
07:50-07:55 น.	48.1	44.9
07:55-08:00 น.	46.8	42.7
08:00-08:05 น.	46.4	43.3
08:05-08:10 น.	46.6	42.4
08:10-08:15 น.	51.6	44.0
08:15-08:20 น.	47.7	42.7
08:20-08:25 น.	51.0	43.9
08:25-08:30 น.	51.8	41.7
08:30-08:35 น.	53.7	43.3
08:35-08:40 น.	46.7	42.8
08:40-08:45 น.	47.0	43.3
08:45-08:50 น.	49.3	44.0
08:50-08:55 น.	45.3	42.3
08:55-09:00 น.	47.9	43.4
09:00-09:05 น.	48.4	42.6
09:05-09:10 น.	46.6	42.8
09:10-09:15 น.	46.4	41.6
UNIT	dB(A)	

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TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
09:15-09:20 น.	50.0	44.8
09:20-09:25 น.	49.0	43.8
09:25-09:30 น.	48.4	44.4
09:30-09:35 น.	47.5	44.0
09:35-09:40 น.	49.4	42.6
09:40-09:45 น.	47.7	43.9
09:45-09:50 น.	45.8	42.4
09:50-09:55 น.	47.7	42.7
09:55-10:00 น.	46.3	43.1
10:00-10:05 น.	48.2	43.5
10:05-10:10 น.	46.5	42.7
10:10-10:15 น.	47.0	43.0
10:15-10:20 น.	47.9	43.6
10:20-10:25 น.	50.7	48.7
10:25-10:30 น.	51.7	50.6
10:30-10:35 น.	51.9	51.1
10:35-10:40 น.	51.7	49.0
10:40-10:45 น.	53.3	49.2
10:45-10:50 น.	51.7	49.6
10:50-10:55 น.	51.9	50.4
10:55-11:00 น.	54.2	52.8
11:00-11:05 น.	51.3	49.7
11:05-11:10 น.	49.3	47.0
11:10-11:15 น.	50.4	48.3
11:15-11:20 น.	52.5	51.2
11:20-11:25 น.	50.0	47.6
11:25-11:30 น.	53.3	50.8
11:30-11:35 น.	51.3	50.7
11:35-11:40 น.	51.0	49.9
11:40-11:45 น.	49.6	48.2
11:45-11:50 น.	48.8	46.5
11:50-11:55 น.	49.1	46.9
11:55-12:00 น.	47.3	45.7
12:00-12:05 น.	48.7	46.0
12:05-12:10 น.	48.4	45.8
12:10-12:15 น.	50.3	49.4
12:15-12:20 น.	49.9	48.6
12:20-12:25 น.	49.2	47.1
12:25-12:30 น.	48.5	47.0
12:30-12:35 น.	46.7	44.3
12:35-12:40 น.	48.1	43.6
12:40-12:45 น.	48.6	43.7
12:45-12:50 น.	49.2	47.3
12:50-12:55 น.	51.0	46.9
12:55-13:00 น.	50.1	46.6
13:00-13:05 น.	50.1	48.8
13:05-13:10 น.	50.1	48.3
13:10-13:15 น.	50.5	49.6
13:15-13:20 น.	50.1	48.7
UNIT	dB(A)	

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TIME*	RESULT	
	BAN WANG TA MUA ROADSIDE COMMUNITY (WANG TA MUA TEMPLE) NAKHON PHANOM	
	APRIL 3- 4, 2017	
	PAF116/2017	
	$L_{Aeq\ 5\ min}$	L_{A99}
13:20-13:25 น.	51.5	49.4
13:25-13:30 น.	55.8	47.4
13:30-13:35 น.	50.0	45.9
13:35-13:40 น.	52.8	46.7
13:40-13:45 น.	50.0	46.3
13:45-13:50 น.	50.0	46.7
13:50-13:55 น.	50.2	46.6
13:55-14:00 น.	51.7	46.8
UNIT	dB(A)	

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ใบรายงานผลการวิเคราะห์

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET
MEASURING TYPE : INTEGRATED SOUND LEVEL METER
MEASURING DATE : APRIL 5-6, 2017
MEASURING TIME : *
MEASURING EQUIPMEN : INTEGRATED SOUND LEVEL METER
MEASURED BY : MR PAIRAT KUMNERDRAKSA
RECEIVED DATE : APRIL 5-6, 2017
ANALYTICAL DATE : APRIL 5-6, 2017
ANALYSIS NO. : PAF117/2017
WORK NO. : FMD1622/2017
REPORT NO. : F00995/2017

TIME*	RESULT	
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET	
	APRIL 5- 6, 2017	
	PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
09:00-09:05 น.	55.7	47.9
09:05-09:10 น.	54.9	48.8
09:10-09:15 น.	52.8	46.0
09:15-09:20 น.	53.4	48.2
09:20-09:25 น.	55.3	48.7
09:25-09:30 น.	52.3	48.3
09:30-09:35 น.	56.4	48.4
09:35-09:40 น.	53.9	50.1
09:40-09:45 น.	54.0	50.5
09:45-09:50 น.	54.3	50.4
09:50-09:55 น.	53.4	50.4
09:55-10:00 น.	54.4	49.1
10:00-10:05 น.	53.0	50.2
10:05-10:10 น.	53.7	51.2
10:10-10:15 น.	54.4	49.6
10:15-10:20 น.	53.8	48.4
10:20-10:25 น.	54.0	50.0
10:25-10:30 น.	54.2	49.7
10:30-10:35 น.	56.8	51.3
10:35-10:40 น.	55.4	50.6
10:40-10:45 น.	56.3	51.1
10:45-10:50 น.	55.1	51.3
10:50-10:55 น.	55.9	51.8
10:55-11:00 น.	55.4	50.2
11:00-11:05 น.	54.5	50.2
11:05-11:10 น.	55.7	51.5
11:10-11:15 น.	54.0	49.3
11:15-11:20 น.	55.1	49.5
11:20-11:25 น.	54.4	49.7
11:25-11:30 น.	55.7	49.1
11:30-11:35 น.	56.8	50.2
11:35-11:40 น.	55.4	49.5
11:40-11:45 น.	55.0	51.0
11:45-11:50 น.	55.6	50.4
11:50-11:55 น.	53.0	47.7
UNIT	dB(A)	

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TIME*	RESULT BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET APRIL 5- 6, 2017 PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A50}
11:55-12:00 น.	53.8	49.6
12:00-12:05 น.	55.2	49.3
12:05-12:10 น.	55.6	50.6
12:10-12:15 น.	53.8	51.0
12:15-12:20 น.	55.3	51.0
12:20-12:25 น.	54.7	50.6
12:25-12:30 น.	53.4	49.8
12:30-12:35 น.	54.3	50.6
12:35-12:40 น.	59.4	50.2
12:40-12:45 น.	56.6	49.3
12:45-12:50 น.	54.2	47.1
12:50-12:55 น.	54.2	48.8
12:55-13:00 น.	52.6	49.9
13:00-13:05 น.	54.0	51.1
13:05-13:10 น.	54.4	51.1
13:10-13:15 น.	53.3	47.8
13:15-13:20 น.	58.0	49.7
13:20-13:25 น.	53.3	49.0
13:25-13:30 น.	56.2	49.9
13:30-13:35 น.	56.3	51.0
13:35-13:40 น.	54.2	50.1
13:40-13:45 น.	52.7	48.0
13:45-13:50 น.	53.5	49.9
13:50-13:55 น.	54.2	50.4
13:55-14:00 น.	53.2	49.8
14:00-14:05 น.	55.1	51.2
14:05-14:10 น.	55.8	50.8
14:10-14:15 น.	53.7	49.1
14:15-14:20 น.	55.0	49.7
14:20-14:25 น.	55.6	48.3
14:25-14:30 น.	54.9	50.7
14:30-14:35 น.	53.4	49.4
14:35-14:40 น.	52.5	49.1
14:40-14:45 น.	56.1	49.8
14:45-14:50 น.	54.5	47.8
14:50-14:55 น.	54.3	50.2
14:55-15:00 น.	54.9	49.5
15:00-15:05 น.	55.5	48.4
15:05-15:10 น.	54.1	50.1
15:10-15:15 น.	54.0	51.3
15:15-15:20 น.	55.0	52.1
15:20-15:25 น.	55.1	50.1
15:25-15:30 น.	54.8	48.9
15:30-15:35 น.	54.3	50.7
15:35-15:40 น.	54.2	49.0
15:40-15:45 น.	54.2	49.4
15:45-15:50 น.	53.4	50.8
15:50-15:55 น.	54.0	49.2
15:55-16:00 น.	53.2	47.5
UNIT	dB(A)	

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TIME*	RESULT BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET APRIL 5- 6, 2017 PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
16:00-16:05 น.	55.2	49.5
16:05-16:10 น.	54.1	49.2
16:10-16:15 น.	55.5	49.6
16:15-16:20 น.	52.1	47.5
16:20-16:25 น.	59.4	49.9
16:25-16:30 น.	55.3	50.5
16:30-16:35 น.	53.7	50.0
16:35-16:40 น.	58.8	50.5
16:40-16:45 น.	55.4	49.9
16:45-16:50 น.	64.5	49.1
16:50-16:55 น.	57.7	50.0
16:55-17:00 น.	57.6	50.2
17:00-17:05 น.	56.1	48.6
17:05-17:10 น.	57.0	50.5
17:10-17:15 น.	56.3	49.6
17:15-17:20 น.	57.9	50.1
17:20-17:25 น.	57.3	49.9
17:25-17:30 น.	61.3	49.6
17:30-17:35 น.	61.5	50.9
17:35-17:40 น.	52.2	47.9
17:40-17:45 น.	53.4	49.5
17:45-17:50 น.	55.0	49.6
17:50-17:55 น.	57.1	51.5
17:55-18:00 น.	53.4	48.4
18:00-18:05 น.	54.6	49.8
18:05-18:10 น.	54.2	47.2
18:10-18:15 น.	54.1	47.9
18:15-18:20 น.	56.9	46.8
18:20-18:25 น.	56.7	48.6
18:25-18:30 น.	54.5	49.1
18:30-18:35 น.	59.2	49.8
18:35-18:40 น.	61.8	61.0
18:40-18:45 น.	55.8	52.0
18:45-18:50 น.	53.2	48.0
18:50-18:55 น.	53.2	47.5
18:55-19:00 น.	52.4	47.7
19:00-19:05 น.	54.0	50.1
19:05-19:10 น.	53.4	46.6
19:10-19:15 น.	51.6	47.3
19:15-19:20 น.	53.3	46.3
19:20-19:25 น.	52.1	46.7
19:25-19:30 น.	51.8	46.1
19:30-19:35 น.	50.1	46.8
19:35-19:40 น.	51.1	46.5
19:40-19:45 น.	51.1	46.7
19:45-19:50 น.	52.7	44.7
19:50-19:55 น.	49.4	44.9
19:55-20:00 น.	51.9	46.1
20:00-20:05 น.	50.8	45.1
UNIT	dB(A)	

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TIME*	RESULT	
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET	
	APRIL 5- 6, 2017	
	PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
20:05-20:10 น.	49.9	44.1
20:10-20:15 น.	50.6	45.0
20:15-20:20 น.	50.9	44.7
20:20-20:25 น.	53.7	48.2
20:25-20:30 น.	51.2	47.2
20:30-20:35 น.	51.1	47.8
20:35-20:40 น.	50.3	44.8
20:40-20:45 น.	51.6	44.9
20:45-20:50 น.	49.6	43.1
20:50-20:55 น.	57.4	46.4
20:55-21:00 น.	52.5	44.7
21:00-21:05 น.	53.9	46.6
21:05-21:10 น.	51.0	46.2
21:10-21:15 น.	51.7	46.1
21:15-21:20 น.	49.6	45.7
21:20-21:25 น.	52.0	46.0
21:25-21:30 น.	51.0	45.9
21:30-21:35 น.	48.9	41.7
21:35-21:40 น.	50.2	43.7
21:40-21:45 น.	50.4	44.2
21:45-21:50 น.	53.6	45.3
21:50-21:55 น.	50.2	44.7
21:55-22:00 น.	50.3	44.3
22:00-22:05 น.	50.2	44.1
22:05-22:10 น.	49.6	42.4
22:10-22:15 น.	50.0	43.8
22:15-22:20 น.	47.8	42.0
22:20-22:25 น.	51.3	44.9
22:25-22:30 น.	50.5	43.9
22:30-22:35 น.	51.2	42.9
22:35-22:40 น.	48.2	41.9
22:40-22:45 น.	49.6	44.3
22:45-22:50 น.	48.2	42.9
22:50-22:55 น.	51.4	44.1
22:55-23:00 น.	50.1	46.1
23:00-23:05 น.	48.2	45.0
23:05-23:10 น.	49.7	45.5
23:10-23:15 น.	51.2	46.9
23:15-23:20 น.	51.4	45.4
23:20-23:25 น.	49.0	43.8
23:25-23:30 น.	53.0	43.8
23:30-23:35 น.	48.2	43.1
23:35-23:40 น.	45.7	41.2
23:40-23:45 น.	50.9	42.0
23:45-23:50 น.	48.9	41.9
23:50-23:55 น.	49.1	41.9
23:55-00:00 น.	50.5	42.7
00:00-00:05 น.	50.0	42.1
00:05-00:10 น.	49.3	41.7
UNIT	dB(A)	

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TIME*	RESULT	
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET	
	APRIL 5- 6, 2017	
	PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{AN6}
00:10-00:15 น.	49.4	41.5
00:15-00:20 น.	48.3	41.2
00:20-00:25 น.	48.3	41.5
00:25-00:30 น.	47.8	40.9
00:30-00:35 น.	46.1	41.2
00:35-00:40 น.	46.4	41.1
00:40-00:45 น.	48.7	41.5
00:45-00:50 น.	46.6	40.5
00:50-00:55 น.	46.0	40.6
00:55-01:00 น.	47.4	40.7
01:00-01:05 น.	49.3	42.1
01:05-01:10 น.	45.3	40.8
01:10-01:15 น.	46.5	41.7
01:15-01:20 น.	49.8	44.8
01:20-01:25 น.	51.3	47.8
01:25-01:30 น.	52.2	50.9
01:30-01:35 น.	51.4	48.7
01:35-01:40 น.	47.8	44.2
01:40-01:45 น.	47.1	42.8
01:45-01:50 น.	48.0	42.8
01:50-01:55 น.	47.2	42.3
01:55-02:00 น.	44.8	41.4
02:00-02:05 น.	46.9	42.1
02:05-02:10 น.	47.3	41.7
02:10-02:15 น.	47.4	42.6
02:15-02:20 น.	46.9	40.4
02:20-02:25 น.	48.7	41.6
02:25-02:30 น.	45.5	40.7
02:30-02:35 น.	45.3	41.2
02:35-02:40 น.	44.7	41.3
02:40-02:45 น.	47.6	42.0
02:45-02:50 น.	44.8	41.0
02:50-02:55 น.	48.7	42.3
02:55-03:00 น.	47.5	41.2
03:00-03:05 น.	51.5	41.8
03:05-03:10 น.	48.2	40.8
03:10-03:15 น.	46.5	40.5
03:15-03:20 น.	46.6	40.8
03:20-03:25 น.	48.4	42.0
03:25-03:30 น.	48.5	43.0
03:30-03:35 น.	45.0	41.2
03:35-03:40 น.	47.8	42.7
03:40-03:45 น.	48.4	43.4
03:45-03:50 น.	48.4	43.7
03:50-03:55 น.	51.2	43.4
03:55-04:00 น.	48.3	43.1
04:00-04:05 น.	51.6	44.6
04:05-04:10 น.	50.6	43.2
04:10-04:15 น.	49.3	45.0
UNIT	dB(A)	

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TIME*	RESULT	
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET	
	APRIL 5- 6, 2017	
	PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
04:15-04:20 น.	50.0	43.9
04:20-04:25 น.	50.3	43.5
04:25-04:30 น.	50.4	43.9
04:30-04:35 น.	47.1	42.7
04:35-04:40 น.	49.3	43.4
04:40-04:45 น.	49.6	43.6
04:45-04:50 น.	50.9	43.8
04:50-04:55 น.	53.2	44.6
04:55-05:00 น.	51.2	44.2
05:00-05:05 น.	51.6	45.3
05:05-05:10 น.	49.2	44.2
05:10-05:15 น.	50.2	44.8
05:15-05:20 น.	52.4	45.5
05:20-05:25 น.	50.1	43.3
05:25-05:30 น.	51.3	44.5
05:30-05:35 น.	52.7	44.4
05:35-05:40 น.	53.7	45.8
05:40-05:45 น.	57.0	55.2
05:45-05:50 น.	57.1	55.3
05:50-05:55 น.	52.5	47.3
05:55-06:00 น.	52.1	46.4
06:00-06:05 น.	51.5	45.3
06:05-06:10 น.	50.7	44.4
06:10-06:15 น.	51.0	42.3
06:15-06:20 น.	57.4	45.6
06:20-06:25 น.	53.2	46.5
06:25-06:30 น.	53.2	44.6
06:30-06:35 น.	52.5	44.7
06:35-06:40 น.	52.3	43.2
06:40-06:45 น.	50.9	45.5
06:45-06:50 น.	52.1	47.1
06:50-06:55 น.	51.8	45.4
06:55-07:00 น.	51.4	45.4
07:00-07:05 น.	54.7	47.1
07:05-07:10 น.	54.2	48.1
07:10-07:15 น.	51.4	45.2
07:15-07:20 น.	51.8	43.2
07:20-07:25 น.	55.0	47.6
07:25-07:30 น.	54.2	48.0
07:30-07:35 น.	52.6	45.9
07:35-07:40 น.	55.1	45.5
07:40-07:45 น.	54.1	47.2
07:45-07:50 น.	54.7	47.5
07:50-07:55 น.	54.6	49.7
07:55-08:00 น.	55.6	49.1
08:00-08:05 น.	54.6	48.5
08:05-08:10 น.	54.5	47.0
08:10-08:15 น.	54.1	47.1
08:15-08:20 น.	53.7	48.0
UNIT	dB(A)	

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TIME*	RESULT	
	BAN NIWET (MUANG THAWAT BURI SCHOOL) ROI ET	
	APRIL 5- 6, 2017	
	PAF117/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
08:20-08:25 น.	52.3	48.1
08:25-08:30 น.	53.7	47.6
08:30-08:35 น.	54.6	46.9
08:35-08:40 น.	53.3	45.8
08:40-08:45 น.	54.4	49.6
08:45-08:50 น.	53.9	49.2
08:50-08:55 น.	53.0	48.3
08:55-09:00 น.	52.6	46.9
UNIT	dB(A)	

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

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ใบรายงานผลการวิเคราะห์

PROJECT NAME : AMBIENT AIR, NOISE AND VIBRATION QUALITY MONITORING
CUSTOMER NAME : ASIAN DEVELOPMENT BANK
ADDRESS : 6 ADB AVENUE, MANDALUYONG CITY 1550, METRO MANILA, PHILIPPINES
TEL. 0 0632 6324 444 FAX 0 0632 6362 444
MEASURING PLACE : THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET
MEASURING TYPE : INTEGRATED SOUND LEVEL METER **RECEIVED DATE** : APRIL 5-6, 2017
MEASURING DATE : APRIL 5-6, 2017 **ANALYTICAL DATE** : APRIL 5-6, 2017
MEASURING TIME : * **ANALYSIS NO.** : PAF118/2017
MEASURING EQUIPMEN : INTEGRATED SOUND LEVEL METER **WORK NO.** : FMD1622/2017
MEASURED BY : MR PAIRAT KUMNERDRAKSA **REPORT NO.** : F00996/2017

TIME*	RESULT	
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET	
	APRIL 5- 6, 2017	
	PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
11:00-11:05 น.	53.3	48.7
11:05-11:10 น.	52.3	49.1
11:10-11:15 น.	50.7	47.9
11:15-11:20 น.	49.3	46.9
11:20-11:25 น.	49.5	46.7
11:25-11:30 น.	48.9	46.4
11:30-11:35 น.	53.4	47.5
11:35-11:40 น.	50.1	47.4
11:40-11:45 น.	48.6	46.4
11:45-11:50 น.	50.4	46.9
11:50-11:55 น.	49.5	46.9
11:55-12:00 น.	50.1	47.5
12:00-12:05 น.	50.5	47.3
12:05-12:10 น.	50.2	46.6
12:10-12:15 น.	48.9	46.9
12:15-12:20 น.	49.2	46.8
12:20-12:25 น.	49.5	46.1
12:25-12:30 น.	49.6	46.3
12:30-12:35 น.	49.0	46.3
12:35-12:40 น.	49.0	46.1
12:40-12:45 น.	51.3	46.5
12:45-12:50 น.	49.1	46.2
12:50-12:55 น.	48.8	46.1
12:55-13:00 น.	51.1	47.0
13:00-13:05 น.	50.2	46.7
13:05-13:10 น.	49.8	46.4
13:10-13:15 น.	49.3	46.4
13:15-13:20 น.	48.8	46.3
13:20-13:25 น.	49.9	46.9
13:25-13:30 น.	49.6	46.0
13:30-13:35 น.	49.4	46.6
13:35-13:40 น.	49.5	46.4
13:40-13:45 น.	50.2	46.6
13:45-13:50 น.	49.2	45.8
13:50-13:55 น.	48.5	45.9
UNIT	dB(A)	

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TIME*	RESULT THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET APRIL 5- 6, 2017 PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A50}
13:55-14:00 น.	49.2	46.1
14:00-14:05 น.	50.5	46.5
14:05-14:10 น.	50.7	46.8
14:10-14:15 น.	49.3	46.6
14:15-14:20 น.	49.6	46.5
14:20-14:25 น.	50.1	47.2
14:25-14:30 น.	50.2	46.6
14:30-14:35 น.	48.9	46.5
14:35-14:40 น.	49.0	46.4
14:40-14:45 น.	50.5	46.2
14:45-14:50 น.	50.1	46.6
14:50-14:55 น.	49.9	46.9
14:55-15:00 น.	50.6	47.5
15:00-15:05 น.	50.6	46.6
15:05-15:10 น.	50.7	47.4
15:10-15:15 น.	51.3	48.2
15:15-15:20 น.	51.3	48.4
15:20-15:25 น.	51.6	47.9
15:25-15:30 น.	52.5	48.2
15:30-15:35 น.	53.0	48.0
15:35-15:40 น.	49.7	46.8
15:40-15:45 น.	52.7	48.4
15:45-15:50 น.	50.8	46.6
15:50-15:55 น.	50.0	46.5
15:55-16:00 น.	49.9	46.4
16:00-16:05 น.	50.6	46.7
16:05-16:10 น.	52.2	46.1
16:10-16:15 น.	51.6	46.7
16:15-16:20 น.	50.3	46.8
16:20-16:25 น.	53.1	46.6
16:25-16:30 น.	51.1	46.9
16:30-16:35 น.	51.6	46.9
16:35-16:40 น.	49.4	47.1
16:40-16:45 น.	49.9	47.3
16:45-16:50 น.	50.4	46.9
16:50-16:55 น.	51.1	47.9
16:55-17:00 น.	48.4	45.6
17:00-17:05 น.	49.9	46.8
17:05-17:10 น.	49.8	46.8
17:10-17:15 น.	48.9	46.5
17:15-17:20 น.	49.7	46.9
17:20-17:25 น.	51.2	46.8
17:25-17:30 น.	49.3	45.9
17:30-17:35 น.	48.7	46.0
17:35-17:40 น.	50.8	46.9
17:40-17:45 น.	49.5	46.8
17:45-17:50 น.	50.1	46.8
17:50-17:55 น.	53.8	46.1
17:55-18:00 น.	60.4	50.5
UNIT	dB(A)	

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TIME*	RESULT THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET APRIL 5- 6, 2017 PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
18:00-18:05 น.	55.2	46.6
18:05-18:10 น.	49.0	46.2
18:10-18:15 น.	49.2	46.1
18:15-18:20 น.	49.4	47.5
18:20-18:25 น.	50.4	48.1
18:25-18:30 น.	52.7	50.6
18:30-18:35 น.	53.8	53.0
18:35-18:40 น.	52.6	48.1
18:40-18:45 น.	50.0	46.4
18:45-18:50 น.	51.6	46.6
18:50-18:55 น.	51.9	47.5
18:55-19:00 น.	47.6	46.2
19:00-19:05 น.	49.2	46.9
19:05-19:10 น.	48.5	46.6
19:10-19:15 น.	48.9	46.7
19:15-19:20 น.	49.6	47.8
19:20-19:25 น.	50.0	47.2
19:25-19:30 น.	49.5	47.8
19:30-19:35 น.	48.9	47.5
19:35-19:40 น.	49.7	48.1
19:40-19:45 น.	51.4	48.1
19:45-19:50 น.	49.5	47.6
19:50-19:55 น.	49.4	47.5
19:55-20:00 น.	49.6	47.8
20:00-20:05 น.	50.0	47.8
20:05-20:10 น.	49.7	47.7
20:10-20:15 น.	49.0	47.3
20:15-20:20 น.	48.9	47.6
20:20-20:25 น.	49.8	47.5
20:25-20:30 น.	49.3	48.1
20:30-20:35 น.	49.5	47.7
20:35-20:40 น.	49.5	47.5
20:40-20:45 น.	48.9	46.5
20:45-20:50 น.	48.9	47.7
20:50-20:55 น.	49.8	47.8
20:55-21:00 น.	49.0	47.7
21:00-21:05 น.	49.3	47.7
21:05-21:10 น.	48.8	47.6
21:10-21:15 น.	48.5	47.4
21:15-21:20 น.	48.4	45.8
21:20-21:25 น.	48.8	46.0
21:25-21:30 น.	47.9	45.9
21:30-21:35 น.	47.6	45.6
21:35-21:40 น.	50.3	48.9
21:40-21:45 น.	49.6	48.5
21:45-21:50 น.	49.8	48.4
21:50-21:55 น.	49.2	48.3
21:55-22:00 น.	49.8	48.5
22:00-22:05 น.	49.1	48.2
UNIT	dB(A)	

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TIME*	RESULT	
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET	
	APRIL 5- 6, 2017	
	PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
22:05-22:10 น.	51.8	46.7
22:10-22:15 น.	46.8	45.5
22:15-22:20 น.	47.2	45.5
22:20-22:25 น.	49.8	47.7
22:25-22:30 น.	51.8	46.5
22:30-22:35 น.	49.4	47.9
22:35-22:40 น.	49.6	47.8
22:40-22:45 น.	48.6	47.7
22:45-22:50 น.	48.5	47.5
22:50-22:55 น.	49.0	47.9
22:55-23:00 น.	48.6	47.6
23:00-23:05 น.	48.8	47.5
23:05-23:10 น.	47.9	46.9
23:10-23:15 น.	48.2	46.4
23:15-23:20 น.	49.2	47.6
23:20-23:25 น.	48.9	47.5
23:25-23:30 น.	47.1	45.7
23:30-23:35 น.	48.1	45.8
23:35-23:40 น.	46.9	45.6
23:40-23:45 น.	46.9	45.6
23:45-23:50 น.	47.9	45.5
23:50-23:55 น.	47.8	45.7
23:55-00:00 น.	46.9	45.3
00:00-00:05 น.	47.6	46.3
00:05-00:10 น.	46.6	46.0
00:10-00:15 น.	46.7	45.6
00:15-00:20 น.	47.2	46.0
00:20-00:25 น.	48.1	46.0
00:25-00:30 น.	48.5	46.4
00:30-00:35 น.	47.0	45.6
00:35-00:40 น.	46.8	45.7
00:40-00:45 น.	47.8	46.1
00:45-00:50 น.	47.4	46.0
00:50-00:55 น.	46.8	45.6
00:55-01:00 น.	46.5	45.5
01:00-01:05 น.	47.0	45.5
01:05-01:10 น.	46.7	45.6
01:10-01:15 น.	46.9	45.6
01:15-01:20 น.	46.8	45.4
01:20-01:25 น.	46.7	45.7
01:25-01:30 น.	47.7	46.0
01:30-01:35 น.	47.1	45.7
01:35-01:40 น.	47.1	46.2
01:40-01:45 น.	47.8	46.2
01:45-01:50 น.	47.0	45.9
01:50-01:55 น.	47.7	46.6
01:55-02:00 น.	49.3	47.5
02:00-02:05 น.	49.5	47.5
02:05-02:10 น.	49.6	48.0
UNIT	dB(A)	

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TIME*	RESULT THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET APRIL 5- 6, 2017 PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
02:10-02:15 น.	48.2	47.2
02:15-02:20 น.	47.7	46.9
02:20-02:25 น.	49.6	48.1
02:25-02:30 น.	48.2	46.7
02:30-02:35 น.	46.9	45.5
02:35-02:40 น.	47.1	45.1
02:40-02:45 น.	46.7	44.7
02:45-02:50 น.	46.1	44.8
02:50-02:55 น.	46.4	44.7
02:55-03:00 น.	45.4	44.6
03:00-03:05 น.	45.4	44.5
03:05-03:10 น.	45.8	44.5
03:10-03:15 น.	46.3	44.7
03:15-03:20 น.	48.3	47.0
03:20-03:25 น.	48.3	47.1
03:25-03:30 น.	48.2	47.0
03:30-03:35 น.	48.3	47.0
03:35-03:40 น.	48.1	46.9
03:40-03:45 น.	50.6	47.0
03:45-03:50 น.	47.9	47.0
03:50-03:55 น.	48.0	47.0
03:55-04:00 น.	48.0	47.1
04:00-04:05 น.	48.4	47.2
04:05-04:10 น.	47.5	46.9
04:10-04:15 น.	49.7	46.8
04:15-04:20 น.	48.4	46.8
04:20-04:25 น.	47.7	46.3
04:25-04:30 น.	47.9	47.0
04:30-04:35 น.	47.7	44.6
04:35-04:40 น.	46.5	44.5
04:40-04:45 น.	46.2	44.5
04:45-04:50 น.	46.8	44.5
04:50-04:55 น.	49.7	44.5
04:55-05:00 น.	46.6	44.5
05:00-05:05 น.	46.0	44.5
05:05-05:10 น.	48.8	44.6
05:10-05:15 น.	47.2	44.2
05:15-05:20 น.	47.5	44.6
05:20-05:25 น.	47.7	44.6
05:25-05:30 น.	48.3	44.9
05:30-05:35 น.	49.0	44.5
05:35-05:40 น.	49.1	45.7
05:40-05:45 น.	52.1	49.4
05:45-05:50 น.	50.8	47.3
05:50-05:55 น.	50.4	46.7
05:55-06:00 น.	62.3	47.8
06:00-06:05 น.	51.2	47.4
06:05-06:10 น.	65.4	46.1
06:10-06:15 น.	57.9	46.7
UNIT	dB(A)	

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TIME*	RESULT	
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET	
	APRIL 5- 6, 2017	
	PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
06:15-06:20 น.	51.3	47.1
06:20-06:25 น.	52.7	47.8
06:25-06:30 น.	52.6	47.1
06:30-06:35 น.	52.3	47.5
06:35-06:40 น.	49.2	46.1
06:40-06:45 น.	50.7	46.4
06:45-06:50 น.	62.9	47.8
06:50-06:55 น.	66.6	57.8
06:55-07:00 น.	62.5	46.2
07:00-07:05 น.	50.5	45.8
07:05-07:10 น.	50.0	45.8
07:10-07:15 น.	50.8	46.7
07:15-07:20 น.	49.3	45.9
07:20-07:25 น.	49.7	46.2
07:25-07:30 น.	49.8	46.5
07:30-07:35 น.	51.4	47.1
07:35-07:40 น.	52.7	47.0
07:40-07:45 น.	50.6	47.0
07:45-07:50 น.	50.2	47.1
07:50-07:55 น.	51.4	46.7
07:55-08:00 น.	51.8	46.7
08:00-08:05 น.	50.1	46.0
08:05-08:10 น.	49.7	46.5
08:10-08:15 น.	49.5	46.1
08:15-08:20 น.	49.8	46.0
08:20-08:25 น.	51.5	46.5
08:25-08:30 น.	54.2	46.6
08:30-08:35 น.	49.0	45.4
08:35-08:40 น.	50.4	46.7
08:40-08:45 น.	50.4	46.2
08:45-08:50 น.	49.5	46.5
08:50-08:55 น.	49.9	46.4
08:55-09:00 น.	49.1	46.0
09:00-09:05 น.	51.6	46.3
09:05-09:10 น.	51.9	46.7
09:10-09:15 น.	51.2	46.8
09:15-09:20 น.	50.4	47.1
09:20-09:25 น.	50.8	46.9
09:25-09:30 น.	51.3	47.6
09:30-09:35 น.	51.0	47.6
09:35-09:40 น.	53.8	49.7
09:40-09:45 น.	52.1	47.6
09:45-09:50 น.	53.0	47.3
09:50-09:55 น.	52.8	47.9
09:55-10:00 น.	57.9	48.1
10:00-10:05 น.	62.3	50.1
10:05-10:10 น.	52.9	47.9
10:10-10:15 น.	51.1	47.4
10:15-10:20 น.	52.7	48.8
UNIT	dB(A)	

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TIME*	RESULT	
	THAM PRADITTHARAM TEMPLE BAN NONYANG ROI ET	
	APRIL 5- 6, 2017	
	PAF118/2017	
	$L_{Aeq\ 5\ min}$	L_{A90}
10:20-10:25 น.	52.0	49.0
10:25-10:30 น.	52.1	48.9
10:30-10:35 น.	52.1	48.3
10:35-10:40 น.	51.3	47.3
10:40-10:45 น.	51.6	48.6
10:45-10:50 น.	51.0	47.2
10:50-10:55 น.	55.1	48.4
10:55-11:00 น.	55.6	48.6
UNIT	dB(A)	

(MR SILA BANJONGJAIRUK)
TECHNICAL MANAGEMENT
APRIL 20, 2017

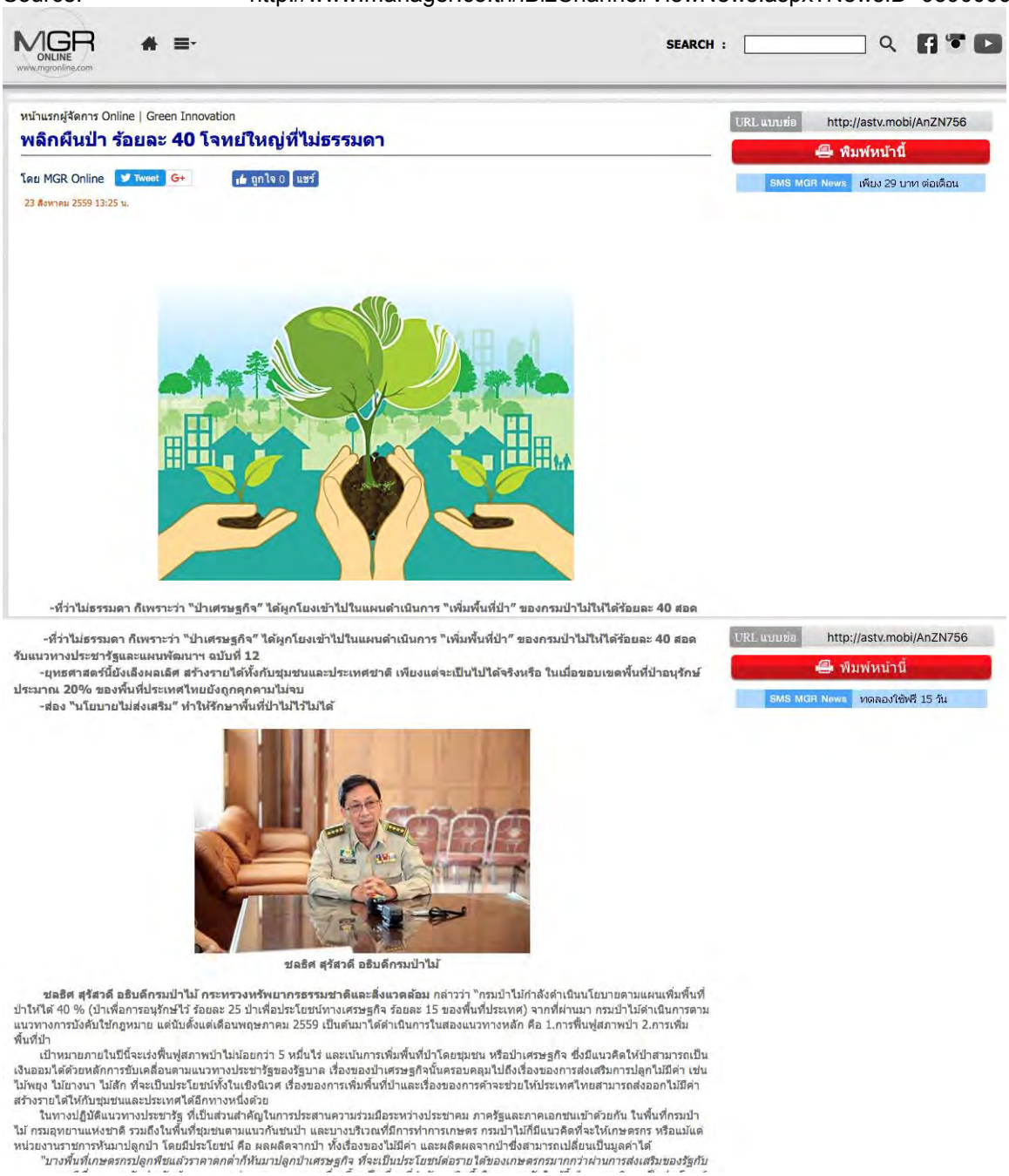
(MISS NANTIDA BOONSAI)
LABORATORY SUPERVISOR
APRIL 20, 2017

Appendix 5: News Articles and Clippings on Tree Planting and Conservation in Thailand

MGR Online

The General Director of the Royal Forest Department said, the government wants to increase the forest area through conservation and rehabilitation of the existing forest and increase the economic forest such as Forest Park that includes Yang Na and Teak tree species.

Source: http://www.manager.co.th/iBizChannel/ViewNews.aspx?NewsID=9590000084309



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หน้าแรกผู้จัดการ Online | Green Innovation

พลิกผืนป่า ร้อยละ 40 โจทย์ใหญ่ที่ไม่ธรรมดา

โดย MGR Online Tweet G+ ถูกใจ 0 แชร์

23 สิงหาคม 2559 13:25 น.

URL แบบย่อ http://astv.mobi/AnZN756

พิมพ์หน้านี้

SMS MGR News เพียง 29 บาท ต่อเดือน

-ที่ว่าไม่ธรรมดา ก็เพราะว่า "ป่าเศรษฐกิจ" ได้ผูกโยงเข้าไปในแผนดำเนินการ "เพิ่มพื้นที่ป่า" ของกรมป่าไม้ให้ได้ร้อยละ 40 สอด

-ที่ว่าไม่ธรรมดา ก็เพราะว่า "ป่าเศรษฐกิจ" ได้ผูกโยงเข้าไปในแผนดำเนินการ "เพิ่มพื้นที่ป่า" ของกรมป่าไม้ให้ได้ร้อยละ 40 สอด
รับแนวทางประชารัฐและแผนพัฒนาฯ ฉบับที่ 12

-ยุทธศาสตร์นี้ยังเล็งผลเลิศ สร้างรายได้ทั้งกับชุมชนและประเทศชาติ เพียงแต่จะเป็นไปได้จริงหรือ ในเมื่อขอบเขตพื้นที่ป่าอนุรักษ์ประมาณ 20% ของพื้นที่ประเทศไทยยังถูกคุกคามไม่จบ

-ส่อง "นโยบายไม่ส่งเสริม" ทำให้รักษาพื้นที่ป่าไม้ไว้ไม่ได้

URL แบบย่อ http://astv.mobi/AnZN756

พิมพ์หน้านี้

SMS MGR News ทดลองใช้ฟรี 15 วัน

ชลธิศ สุรัสวดี อธิบดีกรมป่าไม้

ชลธิศ สุรัสวดี อธิบดีกรมป่าไม้ กระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม กล่าวว่า "กรมป่าไม้กำลังดำเนินนโยบายตามแผนเพิ่มพื้นที่ป่าให้ได้ 40 % (ป่าเพื่อการอนุรักษ์ไว้ ร้อยละ 25 ป่าเพื่อประโยชน์ทางเศรษฐกิจ ร้อยละ 15 ของพื้นที่ประเทศ) จากที่ผ่านมา กรมป่าไม้ดำเนินการตามแนวทางการบังคับใช้กฎหมาย แต่นับตั้งแต่เดือนพฤษภาคม 2559 เป็นต้นมาได้ดำเนินการในสองแนวทางหลัก คือ 1.การฟื้นฟูสภาพป่า 2.การเพิ่มพื้นที่ป่า

เป้าหมายภายในปีนี้จะเร่งฟื้นฟูสภาพป่าไม่น้อยกว่า 5 หมื่นไร่ และเน้นการเพิ่มพื้นที่ป่าโดยชุมชน หรือป่าเศรษฐกิจ ซึ่งมีแนวคิดให้ป่าสามารถเป็นเงินออมได้ด้วยหลักการขับเคลื่อนตามแนวทางประชารัฐของรัฐบาล เรื่องของป่าเศรษฐกิจนั้นครอบคลุมไปถึงเรื่องของการส่งเสริมการปลูกไม้มีค่า เช่น ไม้พยุง ไม้ยางนา ไม้สัก ที่จะเป็นประโยชน์ทั้งในเชิงนิเวศ เรื่องของการเพิ่มพื้นที่ป่าและเรื่องของการค้าจะช่วยให้ประเทศไทยสามารถส่งออกไม้มีค่าสร้างรายได้ให้กับชุมชนและประเทศได้อีกทางหนึ่งด้วย

ในทางปฏิบัติแนวทางประชารัฐ ที่เป็นส่วนสำคัญในการประสานความร่วมมือระหว่างประชาคม ภาครัฐและภาคเอกชนเข้าด้วยกัน ในพื้นที่กรมป่าไม้ กรมอุทยานแห่งชาติ รวมถึงในพื้นที่ชุมชนตามแนวกันชนป่า และบางบริเวณที่มีการทำการเกษตร กรมป่าไม้ก็มีแนวคิดที่จะให้เกษตรกร หรือแม้แต่หน่วยงานราชการหันมาปลูกป่า โดยมีประโยชน์ คือ ผลผลิตจากป่า ทั้งเรื่องของไม้มีค่า และผลิตผลจากป่าซึ่งสามารถเปลี่ยนเป็นมูลค่าได้

"บางพื้นที่เกษตรกรปลูกพืชแล้วราคาตกต่ำก็หันมาปลูกป่าเศรษฐกิจ ที่จะเป็นประโยชน์ต่อรายได้ของเกษตรกรมากกว่าผ่านการส่งเสริมของรัฐกับ

เปิดโครงการประชารัฐร่วมใจ สร้างฝายใต้ป่า บริเวณห้วยลับพร้า บ้านเขาไม้แก้ว ตำบลประสงค์ อำเภอท่าชนะ จังหวัดสุราษฎร์ธานี หนึ่งในการโครงการปกป้องป่า

ปลูกป่า ปลูกคน ในแผนฯ 12

ดำนาย **ลดาวัลย์ คำภา รองเลขาธิการคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ สำนักงานคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ (สภาพัฒน์)** กล่าวว่า ได้กำหนดทิศทางแผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ ฉบับที่ 12 (พ.ศ.2560-2564) มีเป้าหมายชัดเจนกำหนดให้รักษาและฟื้นฟูทรัพยากรธรรมชาติ เพิ่มพื้นที่ป่าเป็น 40% ของพื้นที่ประเทศ แบ่งเป็นพื้นที่เพื่อการอนุรักษ์ 25% และพื้นที่ป่าเศรษฐกิจ 15% พื้นที่ป่าชายเลนเพิ่มจาก 1.53 ล้านไร่ เป็น 1.58 ล้านไร่ ให้แก้ไขปัญหาการบุกรุกที่ดินของรัฐ และลดการสูญเสียความหลากหลายทางชีวภาพ

ทั้งนี้ การอนุรักษ์ฟื้นฟูทรัพยากรป่าไม้ เพื่อสร้างสมดุลธรรมชาติ ปกป้องและฟื้นฟูทรัพยากรป่าไม้และสัตว์ป่า หยุดการทำลายป่า เพื่อรักษาพื้นที่ป่าไม้ 102.3 ล้านไร่ให้อยู่ต่อไป ให้ทุกภาคส่วนนำระบบสารสนเทศมาใช้บริหารจัดการ บังคับใช้กฎหมายอย่างมีประสิทธิภาพและเป็นธรรม เร่งแก้ไขปัญหาซับซ้อนแนวเขตที่ดินของรัฐ โดยใช้หลักเกณฑ์การปรับปรุงแผนที่แนวเขตที่ดินของรัฐแบบบูรณาการ (One Map) ให้เสร็จโดยเร็ว

ขณะเดียวกัน ต้องสนับสนุนการปลูกป่าและฟื้นฟูป่าไม้ด้วยการให้คนและป่าอยู่ร่วมกันอย่างพึ่งพาและยั่งยืนตามแนวพระราชดำรัส "ปลูกป่า ปลูกคน" โดยประยุกต์จากความสำเร็จโครงการของมูลนิธิแม่ฟ้าหลวงในการปลูกป่าและยกระดับคุณภาพชีวิตของชุมชนไปพร้อมๆ กัน ส่งเสริมการจัดการป่าชุมชน สนับสนุนกฎหมายเกี่ยวกับป่าชุมชน สร้างเครือข่ายการมีส่วนร่วมในการฟื้นฟูและดูแลพื้นที่ป่า เพิ่มพื้นที่ปลูกป่าเศรษฐกิจให้ได้ตามเป้าหมาย 15% ของพื้นที่ทั้งหมด ด้วยการส่งเสริมการปลูกไม้มีค่าทางเศรษฐกิจระยะยาว เช่น ไม้สัก ไม้มะค่าและไม้พะยูง โดยการปรับปรุงกฎระเบียบ เพื่อส่งเสริมและสร้างแรงจูงใจให้ภาคเอกชน ภาคประชาชนและเกษตรกรรายย่อยปลูกไม้มีค่าทางเศรษฐกิจ รวมถึงให้เปลี่ยนการปลูกไม้เศรษฐกิจระยะสั้นเป็นระยะยาว

สำหรับประเทศไทยนั้น มีศักยภาพด้านการปลูกและพัฒนาไม้มีค่าทางเศรษฐกิจมาก โดยเฉพาะ ไม้สัก เพราะมีความเหมาะสมทางภูมินิเวศและคุณภาพของสายพันธุ์ ไม้พื้นถิ่นของไทยเป็นที่ต้องการของตลาดโลก และมีมูลค่าสูงมาก จึงควรส่งเสริมให้เกษตรกรปลูกไม้เศรษฐกิจ โดยภาครัฐต้องดูแลทั้งห่วงโซ่การผลิต

กำลังพลทหารตามนโยบายหวงคืนผืนป่าและการบังคับใช้กฎหมายต่อพื้นที่ป่าที่ถูกบุกรุกปลูกยางพารา ป่าสงวนแห่งชาติป่าแม่งาวฝั่งซ้าย ในพื้นที่หมู่บ้านปันพัฒนา หมู่ที่ 9 ตำบลปงเตา อำเภองาว จังหวัดลำปาง

URL แบบย่อ http://astv.mobi/AnZN756
พิมพ์หน้านี้

หนุนออกพันธบัตรป่าไม้

นอกจากนี้ จะต้องจัดตั้งตลาดกลางค้าไม้ พัฒนาระบบโลจิสติกส์สำหรับการค้าไม้และขนส่งไม้ สนับสนุนกลไกทางการเงินเพื่อการปลูกป่า เช่น การออกพันธบัตรป่าไม้ ธนาคารต้นไม้ หรือกองทุนส่งเสริมการปลูกป่า การวิจัยและพัฒนาการปลูกพืชแซมในสวนป่า ทำวนเกษตร เพื่อสร้างรายได้ให้เกษตรกรในช่วงที่ป่ายังไม่เติบโต วิจัยและพัฒนานวัตกรรมเพื่อสร้างมูลค่าเพิ่มจากไม้ หาแนวทางสร้างรายได้ให้ชุมชนจากการอนุรักษ์เพื่อส่งเสริมการท่องเที่ยวอย่างยั่งยืน

อย่างไรก็ตาม การปลูกสวนป่าเศรษฐกิจ ซึ่งเป็นไม้ที่มีรอบตัดระยะยาว การปลูกพืชแซมสวนป่า เพื่อสร้างรายได้จึงเป็นสิ่งสำคัญที่ไม่ควรมองข้าม เพราะเป็นโครงการที่มีประโยชน์ร่วมกันทั้งด้านรายได้ การฟื้นฟูระบบนิเวศ และการดูดซับก๊าซเรือนกระจก ซึ่งจะทำให้การเติบโตอย่างสีเขียว ทั้งในระดับประเทศ และระดับโลก

สำหรับหน่วยงานหลักที่จะต้องดำเนินการนั้น จะต้องบูรณาการร่วมกันหลายภาคส่วน โดยสภาพัฒน์จะต้องร่วมกับกรมป่าไม้ องค์การอุตสาหกรรมป่าไม้ โครงการอนุรักษ์พันธุกรรมพืชอันเนื่องมาจากพระราชดำริ คือ โครงการมหิดรักษ์ สักสยามมินทร์ สำนักงานปฏิรูปที่ดินเพื่อเกษตรกรรม สถาบันการศึกษา ธนาคารเพื่อการเกษตรและสหกรณ์และภาคเอกชน โดยดำเนินงานในรูปแบบคณะทำงาน เพื่อจัดทำยุทธศาสตร์การพัฒนาการปลูกไม้เศรษฐกิจทั้งระบบ และขับเคลื่อนการดำเนินงานตามยุทธศาสตร์ให้บรรลุเป้าหมาย ซึ่งจะต้องดำเนินงานตามกรอบของสภาพัฒน์ คือ ปี 2560-2564

อ.อ.ป. กังวลคนส่วนใหญ่ไม่เข้าใจ

พิพัฒน์ ชนินทยุทธวงศ์ ผู้อำนวยการองค์การอุตสาหกรรมป่าไม้ (อ.อ.ป.) ได้แสดงความกังวลต่อความเข้าใจของคนไทยที่มีต่อป่าเศรษฐกิจกับป่าอนุรักษ์ โดยทั่วไปมองว่า ป่าอนุรักษ์คือ การเก็บ ป่าเศรษฐกิจ คือ พื้นที่ที่เราสร้างขึ้นมาแล้วเอามาใช้ประโยชน์ แต่ตามหลักวิชาการป่าอนุรักษ์ก็ควรเอามาใช้ อยู่ที่ว่าเราจะเอามาใช้อย่างไร เพราะการอนุรักษ์ไม่ใช่แค่การเก็บอย่างเดียว แต่คือทำอย่างไรให้เกิดประโยชน์สูงสุด

"ความไม่เข้าใจของคนชั้นกลางในเมืองที่เป็นห่วงและไม่มั่นใจการบริหารจัดการป่าของรัฐ ตรงนี้เป็นหน้าที่ของอ.อ.ป. หน้าที่กรมป่าไม้ ทำอย่างไรจะทำความเข้าใจกัน"

ผอ.อ.อ.ป.ย้อนเวลากับไปในช่วงปี 2537-2547 ป่าของไทยหายไปนาทีละ 5 ไร่ และตั้งแต่ปี 2541 อ.อ.ป. เริ่มปลูกต้นไม้ จนปัจจุบันมีพื้นที่ป่าอยู่กว่าล้านไร่ เป็นพื้นที่ป่าสัก ป่าเศรษฐกิจราว 6 แสนไร่ จำนวนดังกล่าวถือว่ายังน้อยมากหากเทียบกับการใช้ไม้ของคนในประเทศ เราเลยต้องนำเข้าไม้จากต่างประเทศสูญเงินจำนวนมหาศาลในแต่ละปี

ผอ.อ.อ.ป.ตั้งคำถามและบอกว่า ประเทศไทยอยู่ในเส้นศูนย์สูตร ตรงนี้สามารถปลูกป่าได้ภายในระยะไม่นาน ป่าเศรษฐกิจสร้างได้ เอาไม้มาใช้ประโยชน์ได้ แต่ทำไมไม่ดิ้นรนในการสร้าง เราไปซื้อไม้จากต่างประเทศทำไมมากมาย หากเรามีพื้นที่สามารถจะปลูกขึ้นมาใช้งานได้"

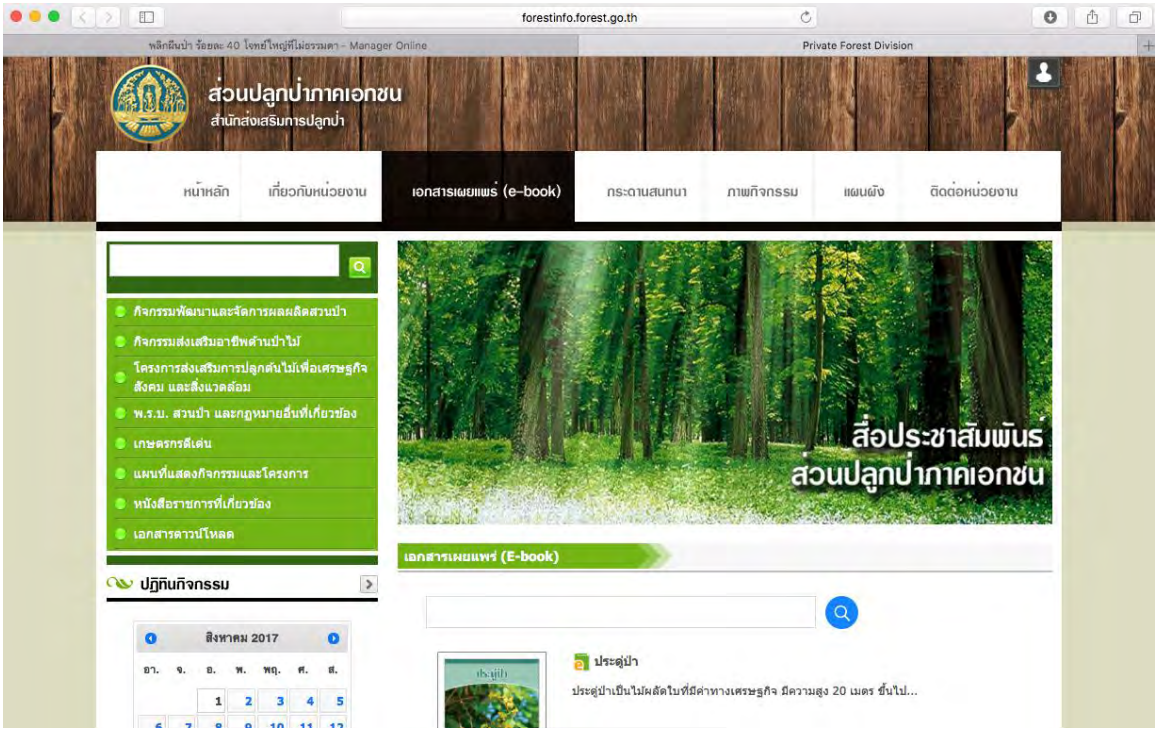
ปัญหาที่จะเจอต่อมาคือ ถ้าจะสร้างเราจะมาอาศัยพื้นที่ป่าธรรมชาติ พื้นที่ป่าสงวน พื้นที่ป่าอนุรักษ์ คงจะไม่ได้ คงต้องอาศัยพื้นที่ที่เป็นของเอกชน พื้นที่เอกสารสิทธิ์ พื้นที่เกษตรกรรม พื้นที่รกร้างว่างเปล่า พื้นที่ปลูกพืชที่ให้ผลตอบแทนไม่คุ้มค่า หรือจะปลูกพืชเกษตรและปลูกป่าควบคู่กันไป

ข่าวล่าสุด ในหมวด
- SE กระตุกต่อมคิด สังคมกับธุรกิจ จากงาน SET Social Impact Day 2017
- ราชบุรีโฮลดิ้งเดินหน้าโครงการ "สุขสูงวัย สร้างไทยแข็งแรง"
- เคทีซีส่งภาษามือ...ชวนน้องเรียนรู้วิถีแห่งสติ
- ธพว.ตอบโจทย์ความยั่งยืน มุ่งพัฒนาต้นแบบ SME4.0
- บ้านปูฯ แนะแนวอาชีพเยาวชนยิดีใหม่ผ่านพี่ต้นแบบ

Royal Forest Department website

The Private Reforestation Division, Reforestation Promotion Office of RFD announced the technical guidelines on the restricted trees planting such as Yang Na and Teak as the Forest Park.

Source: http://forestinfo.forest.go.th/pfd/eBooks.aspx



Appendix 6: CRTA Noise Inputs and Modelling Results

	NH22 (Nakon Phanom)	NH22 (Sakon Nakhon – Nakon Phanom)	NH23 (Roi Et – Yasothon)
Total vehicle flow			
• 2016	11864	6108	14815
• 2040	22288	22207	18610
Speed	60 kph	60 kph	60 kph
Heavy vehicles	11.39%	13.03%	11.89%
Terrain	Plain	Plain	Plain
Normal traffic growth rate	2.5%	3.0%	2.5%
Gradient	3.3%	3.3%	3.3%
Road surface	Impervious	Impervious	Impervious
Distance from edge of carriageway	100	80	75
Source/receiver height difference	3.5	3.5	3.5
Barrier dimensions			
• ds	50	40	40
• hs	0.5	0.5	0.5
• dr	50.0	40.0	35.0
• hr	4.0	4.0	4.0
• hb	3.0	3.0	3.0
Absorbent ground cover	0.5	0.5	0.5
Average path height	2.25	2.25	2.25
Angle of view	120	120	120
Total angle of reflective surfaces	45	45	45
Predicted noise level			
• 2016	59.8	59.7	64.7
• 2040 (without mitigation)	62.6	65.3	65.7
Increase	2.8	5.6	1.0

Notes:
From Calculation of Road Traffic Noise, Department of Transport, UK

The Calculation of Road Traffic Noise (CRTN), 1988, is a noise model platform that was introduced and issued by the U.K. Department of Transport (CRTN-ISBN 0 11 550847). The model uses a basic approach for calculating road traffic noise levels for non-complex situations. The model has limitations in terms of calculating any complex arrangements since only road segment noise at assessment points is calculated. It gives a prediction of noise levels in receptor locations by incorporating information on geographical features, reflectors and distances of the highway from receptors.

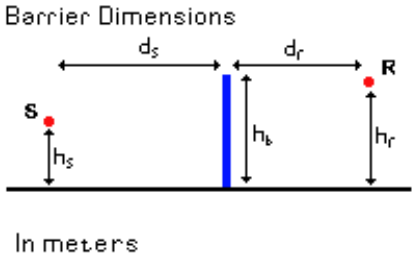
1. The basic noise level at a reference distance of 10 m away from the nearside carriageway edge is obtained from the traffic flow, the speed of the traffic, the composition of the traffic, the gradient of the road and the road surface. On any given road, the traffic flow, mean speed and composition are interdependent. Increasing the traffic flow may cause a reduction in the mean speed so that the net increase in noise level may be comparatively small. When estimating noise levels for projected road schemes, the values adopted for the traffic parameters should be compatible. When dealing with existing roads, it may sometimes be desirable to make observations of these traffic parameters.

2. For roads which are impervious to surface water and where the traffic speed is greater or equal to 75 km/h, the correction is as follows:

- For concrete surfaces = 10 log10 (90 TD + 30) – 20 dB(A)
- For bituminous surfaces = 10 Log10 (20TD + 60) – 20 dB(A); where TD is the texture depth or amount of texture on the road surface, whether this texture is random distributed chippings (as in bituminous surfaces) or transversely aligned (as for concrete surface), and for bituminous surfaces, whether they are essentially impervious to surface water or have an open structure with rapid drainage qualities.

3. For impervious bituminous and concrete road surfaces, 1 dB(A) should be subtracted from the basic noise level when the traffic speed is <75 kph. Road surfaced with pervious macadams have different acoustic properties and 3.5 dB(A) should be subtracted from the basic noise level for all traffic speeds.

4. The following are the barrier dimensions. The values inputted in the model were based on site observations such as presence, height, and distance of fence from road.



5. To forecast the L_{10} value relating to future traffic conditions (signified Q', V', p', the following procedure is adopted (where Q, V, p are the current traffic conditions). Q' is the 18-hour traffic flow for future traffic conditions; V' is the mean speed of traffic for future traffic conditions (km/h) and p' is the percentage of heavy vehicles for future traffic conditions (%).
    a. From the measurement method evaluate L_{10} (dBA value at the reception point for the current traffic conditions.
    b. Calculate the correction (ΔLf**)** to take account of the change in traffic conditions, where:

$$\Delta L_F = 10\,\mathrm{Log}_{10}(Q'/Q) + 33\,\mathrm{Log}_{10}\left[\frac{V' + 40 + \frac{500}{V'}}{V + 40 + \frac{500}{V}}\right] + 10\,\mathrm{Log}_{10}\left[\frac{1 + \frac{5p'}{V'}}{1 + \frac{5p}{V}}\right]$$

    c. Calculate the future value of L10 (Lf) from one of the following formula:
        - If Q and Q' ≥4000 veh/18-hour day, then Lf = L + ΔLf
        - If Q ≥ 4000 and Q' < 4000 veh/18-hour day, then

$$L_F = L + \Delta L_F - 16.6 \left(\mathrm{Log}_{10}\frac{30}{d'}\right)\left(\mathrm{Log}_{10}\frac{Q'}{4000}\right)^2$$

where d' is the shortest slant distance between the reception point and the effective source position.
Note that if d' ≥ 30m Lf = L + ΔLf

- If Q < 4000 and Q' ≥ 4000 veh/18-hour day, then

$$L_F = L + \Delta L_F + 16.6 \left(\text{Log}_{10} \frac{30}{d'} \right) \left(\text{Log}_{10} \frac{Q}{4000} \right)^2$$

Note that if d' ≥ 30m Lf = L + ΔLf

- If Q and Q' <4000 veh/18-hour/day, then

$$L_F = L + \Delta L_F - 16.6 \left(\text{Log}_{10} \frac{30}{d'} \right) \left(\text{Log}_{10} \frac{Q'}{Q} \right) \left(\text{Log}_{10} \frac{QQ'}{4000^2} \right)$$

Note that if d' ≥ 30m Lf = L + ΔLf

Note that when predicting future values of L10 dBA foreseeable changes in screening, site layout and road surface including the criteria for traffic speed should be taken into account.